

กรมโรงงานอุตสาหกรรม
DEPARTMENT OF INDUSTRIAL WORKS

Thailand
HCFC Phase-out Management Plan (Stage I)

ENVIRONMENTAL MANAGEMENT PLAN

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B. Grimm Airconditioning Co., Ltd.

January 2014

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List of Abbreviations

| | |
|-----------------|--|
| ASME | American Society of Mechanical Engineers |
| CAS No | Chemical Abstract System Number |
| CEC | Canadian Electric Code |
| CFC | Chlorofluorocarbons |
| CO ₂ | Carbon dioxide |
| dB | Decibel |
| DIW | The Department of Industrial Works |
| EC | European Country |
| EHS | Environmental, Health and Safety |
| EMP | Environmental Management Plan |
| Ex | Explosive / explosion |
| GHG | Greenhouse Gases |
| GHS | Global Harmonized System |
| GSB | Government Savings Bank |
| GWP | Global Warming Potential |
| HCFC | Hydro chlorofluorocarbons |
| HPMP | HCFC Phase-out Management Plan |
| IEC | International Electrical Code |
| LEL | Lower Explosive Limit |
| MLF | Multilateral Fund |
| MOI | The Ministry of Industry |
| MSDS | Material Safety Data Sheet |
| MT | Metric Tons |
| NEC | National Electric Code |
| NFPA | National Fire Protection Association |
| NOU | The National Ozone Unit |
| ODS | Ozone-Depleting Substances |
| OHS | Occupational Health and Safety |
| PLC | Programmable Logic Controller |
| PMU | Project Management Unit |
| SME | Small and Medium-size Enterprises |
| TISI | Thai Industrial Standard Institute |
| SOP | Standard Operating Procedures |

1. Introduction

Thailand, as one of the Article 5 Countries, had agreed to start freezing HCFC consumption from 2013 at the average of 2009 and 2010. According to the Montreal Protocol, consumption of HCFC must be reduced from the baseline consumption by 10% by 2015, by 35% by 2020, by 67.5% by 2025 and 100% phase-out by 2030. However, the annual consumption will be allowed at 2.5% of the baseline consumption during the year 2030 to 2040 for servicing existing HCFC-based equipment. The Department of Industrial Works (DIW) with assistance from the World Bank prepared and submitted HCFC Phase-out Management Plan (HPMP) Stage I to the Executive Committee in 2012 to seek financial support from the Multilateral Fund (MLF) to assist Thailand to meet obligations under the protocol. At the 68 meeting in December 2012, the HPMP Stage I was approved by the Executive Committee. The HPMP Stage 1 aims to enable Thailand to meet the freeze by 2013, 10% reduction by 2015 and 15% reduction by 2018. This project includes conversion of air-conditioner production at 12 air conditioner manufacturing companies to phase out the use of HCFC-22 and convert their production process to HFC-32 as refrigerant. These air-conditioner manufacturers are

1. Uniaire Corporation Co., Ltd.
2. Saijo Denki International Co., Ltd.
3. Subsuksiri Co., Ltd.
4. Thrub Thong Hou Co., Ltd.
5. PPJ Engineering Limited
6. Unico Consumer Products Co., Ltd.
7. Supreme CNB Corporation Co., Ltd (C.N.E. Industry Group)
8. Eminentair (Thailand) Co., Ltd.
9. B.Grimm Airconditioning Ltd.
10. Better Living Co., Ltd.
11. Bitwise (Thailand) Co., Ltd.
12. Pan-Tycoon Co., Ltd.

B. Grimm Airconditioning Co., Ltd. is one of the companies participating in the HCFC Phase-out Management Plan (HPMP). This Environmental Management Plan-EMP has been prepared specifically for B. Grimm Airconditioning Co., Ltd.. The layout and content of the EMP is consistent with the guideline provided by World Bank's Operational Policy OP/Bank Procedure (BP) 4.01. Additionally, the Thai national laws and regulations, and manufacturing best practices are used as the base in the process of preparing the EMP. The content of this EMP provides guidelines primarily to management, supervisors and employee of B. Grimm Airconditioning Co., Ltd. to run its air conditioner production facilities and also the suppliers and contractors during the conversion where HFC-32 to be used as refrigerant in safe, healthy manner and minimum impact to environment. The conditions that had been observed during site visit by the consultants and reviewing of available documents provided by the company as part of Occupational, Health and Safety Due Diligence are also highlighted in this document.

B. Grimm Airconditioning Co., Ltd. demonstrates good safety, health and environmental standard in their operation. There are procedures and work instructions establishment to ensure high quality, safe and environmental protection practices are adopted by the workforce. The Environmental Management Plan suggests several Standard Practices to prevent shortcutting the operation procedures, which eventually becomes accepted practice. For instance, the poor housekeeping of a work station can lead to not only accident of employee but also accumulation of combustible material that will lead to fire hazard from leakage of flammable gas and ignition sources. To avoid small malfunction of equipment, the operator should manage and maintain equipment and machineries in good conditions at all times. Moreover, there is need to implement good machinery maintenance practice by qualified officers to prevent the leakage of flammable gases, oxygen or refrigerants. In general, the guidance described in the EMP is to be implemented along with the Thai Industrial International Standards - TIS 18001 system and International Standard Organization - ISO 14001 systems. The findings that are raised in the due diligence section are a summary of the consultant's observation, which will be used as the guidance for the company's management, The photos taken with the permission of management during the site visit illustrates the substandard conditions and

practices that can cause injury, illness to the employee, or potential impact to the environment and should be considered by management to prepare further corrective and preventive actions plans. The potential hazards and risk that are associated with operation of machineries, the processes to finalize good air conditioning, parts for the Original Engineering Manufacturing (OEM) or other Air Conditioner assembly lines which could have been impacted by the conversion from HCFC-22 to HFC-32 have been addressed in this Environmental Management Plan (EMP). Proposed changes or modifications of plant equipment, lay-out to meet regulatory requirement or recognized international engineering standards are included in each section of the plan. The goal of this Environmental Management Plan (EMP) is to develop best manufacturing practices with well- established safe procedures that prevent any possible accident. A well-constructed plant with well-maintained safeguards is critical for safe and effective production facility.

It is the overall responsibility of companies' management as required by Thai Occupational Safety and Health (OSH) Laws and regulations to ensure that related operation, activities are adequately controlled. The responsibility to ensure there is no adverse impact on the neighborhood, community and environment is also a critical part that has been addressed in this report.

2. Objectives of this Environmental Management Plan (EMP)

- 2.1 Identify potential risk associated with the conversion from HCFC-22 to HFC-32 by the company compared to their baseline situation,
- 2.2 Provide information on safety and environmental requirements and capacities needed for the introduction of HFC-32 technology.
- 2.3 Describe procedures and methodologies for proper handling of HFC-32 and installation of related equipment, in particular protective equipment and safety measures for the use of HFC-32 in compliance with applicable national regulations and international standards.
- 2.4 Specify roles and responsibilities, and outline the necessary reporting and approval procedures, for the management and monitoring of environmental concerns related to the conversion activities and the use of the HFC-32

3. Background of Air conditioner Manufacturing Process

B. GRIMM AIRCONDITIONING CO., LTD.

Managing Director : Mr. TanongsakChuerkitkumchorn

Located : (Office/Factory)

58 Moo 14, Suwinthawong Rd.,

Krathoomria, Nongjork, Bangkok 10530 Thailand

Tel : (662) 988 2391-7

Fax: (662) 988 240

Factory Area : 15,528 square meters

Production Area : 7,200 square meters

Established : 15 August 1994

Major Business: Manufacture: Air conditioner assembly, Heating and cooling machine, Electrical Control Panel and spare parts or materials of those products.

Brand name: Carrier

Est. 2012 Sales : 40 Mil. US\$

Estimate 2012 Volume : 56,000 boxes

Workforce: 180 persons

Credential certification: Certified ISO 9001:2008 by SGS

B. Grimm Air Conditioning Co., Ltd. has initial factory license (พ. 4) number 3-71-2/37 On 2nd March B.E.2537

The first registered total horse power of machineries was 361 and man-power was 185 persons. The manufacturers' products are Air conditioner assembly, Heating and Cooling machine, Electrical control panel, spare parts and equipment of all those products.

The factory license specifies the conditional requirements as follow;

- Dust control and prevention measurement from powder coating process that prohibit to nuisance dust to employees and neighbor.
- Waste Management System in place; Waste Segregation storage area and dispose to authority approval waste disposal service provider from Department of Industrial Work by followed DIW Disposal of Waste in B.E. 2548 legal requirement

In B.E. 2553, the 1st Expansion license has been granted. The maximum horse powers reach 654.61 which is remaining the same until now. The operating license has been recently renewed on December 31, B.E. 2556.

Due to the fact that factory is located among the residential area. Effective control of community impact is understandable and is one of the key concerns that have been addressed as a conditional operating license approval.



The owner of this facility is belonged to Link Manufacturing 1999 Co., Ltd. This rental contract has been signed on 1st May B.E. 2554 with the rental fee in monthly rate is 270,000 THB and this contract is effective within 3 years.



This facility is registered under SIC no. 70, 71 Production components and assembly air conditioner.



B. Grimm Air Conditioning Co., Ltd. factory is located in a populated area of Krathoomrai, Nongjork, Bangkok Province. The factory is a story building that has totally 7,200 square meters for production lines and office spaces. (Attachment 3- Plant Lay-Out)



The production in this factory produces metal parts for air conditioner assembly line. In sheet metal section, there are CNC Punching machines, shearing machines, bending machines and press machines. There is powder coating process, metal cleaning in the same area as metal sheet production line.


4. Due Diligence: Observations, Impacts and Proposed Mitigations



| | Section | Concerned Process/Location | Findings/Observations | Proposed Mitigation Measures See more detail in Annex 2 |
|---|--|-----------------------------|--|---|
| 1 |  | Waste water treatment plant | Chemical drums shall be placed in the secondary containment. | Empty container shall be kept separately. Keep the lid of the container closed. SOP for handling and dispose empty chemical containers. Eye wash and shower station |
| 2 |  | Waste water treatment plant | Chemical drums shall be placed in the secondary containment. | Empty container shall be kept separately. Keep the lid of the container closed. SOP for handling and dispose empty chemical containers. Eye wash and shower station |



| | Section | Concerned Process/Location | Findings/Observations | Proposed Mitigation Measures See more detail in Annex 2 |
|---|--|----------------------------|---|--|
| 3 |  | Chemical store | Positive observation Designated responsible person has been identified. Areas are clean, no sign of spill or leakage. | Regular inspect for crack or leak on the secondary containment. Check rain water containing inside secondary containment before release. |
| 4 |  | Chemical store | Positive observation Designated responsible person has been identified. Areas are clean, no sign of spill or leakage. | Regular inspect for crack or leak on the secondary containment. Check rain water containing inside secondary containment before release. |

| | Section | Concerned Process/Location | Findings/Observations | Proposed Mitigation Measures See more detail in Annex 2 |
|---|--|----------------------------|--|---|
| 5 |  | Refrigerant storage | Positive observation Well arranged, secured area to prevent unauthorized person | Follow guidelines for storage area of flammable refrigerant /gases |
| 6 |  | Refrigerant storage | Shall be separated from other material. Area shall be fenced off. | Electrical equipment in the area where HFC- 32, to be complied with IEC standards |

| | Section | Concerned Process/Location | Findings/Observations | Proposed Mitigation Measures See more detail in Annex 2 |
|---|--|----------------------------|--|--|
| 7 |  | Working and walkways | Positive observation of well-maintained equipment, well organized working area, clean and tidy | Keep walkway and evacuation routes clear of obstruction. |
| 8 |  | Working and walkways | Positive observation of well-maintained equipment, well organized working area, clean and tidy | Keep walkway and evacuation routes clear of obstruction. |

| | Section | Concerned Process/Location | Findings/Observations | Proposed Mitigation Measures See more detail in Annex 2 |
|---|--|----------------------------|--|--|
| 9 |  | Working and walkways | Positive observation of well maintained equipment, well organized working area, clean and tidy | Keep walkway and evacuation routes clear of obstruction. |

| | Section | Concerned Process/Location | Findings/Observations | Proposed Mitigation Measures See more detail in Annex 2 |
|----|--|----------------------------|-----------------------|--|
| 10 |  | Oxy-Propane welding gases | No flashback arrester | See more detail on Oxy-Fuel gas welding guidelines |
| 11 |  | Oxy-Propane welding gases | No flashback arrester | See more detail on Oxy-Fuel gas welding guidelines |

| | Section | Concerned Process/Location | Findings/Observations | Proposed Mitigation Measures See more detail in Annex 2 |
|----|--|---------------------------------|---|--|
| 12 |  | Electronic gas leak test device | Positive observation Well-maintained, calibrated | Calibration records shall be kept. |
| 13 |  | Electronic gas leak test device | Positive observation Well-maintained, calibrated | Calibration records shall be kept. |

5. Project Description

5.1 HCFC Phase-out Management Plan (HPMP)

The Project Objective is to reduce HCFC consumption in the air-conditioning and foam sectors in order to contribute to Thailand's efforts to meet its HCFC consumption phase-out obligations under the first phase of the program (2014-2018).

As a country operating under Article 5 of the MP (article 5 country), Thailand is obliged to reduce its HCFC consumption in accordance with the schedule shown in the table 5-1 below. Also, as operating under Article 5 of the MP, Thailand is eligible for Multilateral Fund (MLF) funding to support its HCFC phase-out activities.

Table 5-1: Thailand HCFC Phase-out Obligations under the Montreal Protocol

| | Consumption Reduction Targets | Allowable Consumption (ODP tons) | |
|-------------|--|----------------------------------|--|
| | | MP Requirements | As per Agreement between Thailand and Executive Committee (HPMP Stage I) |
| 2013 | Freeze at baseline level (Baseline defined as average of 2009 and 2010 consumption) | 927.6 | 927.6 |
| 2015 | Reduction to 90% of the baseline | 834.8 | 834.84 |
| 2018 | Interim reduction step as per the agreement between Thailand and Executive Committee | 834.8 | 788.46 |
| 2020 | Reduction to 65% of the baseline | 602.9 | |
| 2025 | Reduction to 32.5% of the baseline | 301.5 | |
| 2030 | Reduction to 2.5% of baseline | 23.2 | |
| 2040 | Complete phase-out of HCFCs | 0 | |

*Per the MP, the annual consumption averaged over the ten years from 2030 to 2040 should not exceed 2.5% of the baseline and this quantity is allowed only for the purpose of servicing the remaining fleet of HCFC-dependent equipment.

Thailand is a large importer and user of HCFCs, with a total of 16,890 metric tons of HCFCs imported in 2010. [As per the MP definition, net import is equal its MP consumption.] The two HCFCs most predominantly in use are HCFC-22 and HCFC-141b. Thailand has no HCFCs production capacity.

5.2 HCFC Phase-out Strategy

A HCFC Phase-out Management Plan (HPMP) has been developed by DIW in consultation with the Thai industry and with the assistance of the World Bank. As per the guidelines of the MLF, the HPMP was submitted to the Executive Committee with a request for funding for Stage 1, i.e. funding for meeting the reduction target in 2015. The Executive Committee has endorsed the HPMP and approved a total of US\$ 23.05 million for the implementation of stage 1 of the Thai HPMP, of which, US\$ 22.75 million will be implemented through the World Bank and the remaining of US\$ 0.30 million will be implemented bilaterally with the Government of Japan.

The Thai HPMP reveals that sector distribution of HCFC use is concentrated in manufacturing foam products and air-conditioning and refrigeration equipment, and for servicing, in installed equipment. Consumption of HCFC-141b and HCFC-225 as solvents exists at a much smaller scale, as does HCFC-123 for installation and for servicing. There was sporadic, low-level consumption of HCFC-224 and HCFC-142b across the last five years as substances in refrigerant blends for servicing and for XPS foam. The Government of Thailand will focus its phase-out activities under this project on the foam and air-conditioning manufacturing sectors. The air-conditioning sector will also provide the

greatest opportunity in avoiding CO2 emissions because of the large potential gains in energy efficiency.

Table 5-2: HCFC Consumption in Manufacturing and Servicing in Thailand: 2006-2010*

| Consumption (MT) | 2006 | 2007 | 2008 | 2009 | 2010 |
|--------------------------------|-------|-------|-------|-------|-------|
| HCFC-22 Manufacturing | 6,598 | 7,546 | 7,185 | 5,687 | 8,805 |
| HCFC-22 Servicing | 4,783 | 5,055 | 5,377 | 5,646 | 5,991 |
| HCFC-123 Installation | 66 | 47 | 55 | 52 | 52 |
| HCFC-123 Servicing | 82 | 61 | 72 | 71 | 73 |
| HCFC-141b Foam Manufacturing** | -- | 1,438 | 1,636 | 1,619 | 1,723 |
| HCFC-141b Solvents | -- | 170 | 205 | 192 | 198 |
| HCFC-225 Solvents | 329 | 0 | 69 | 69 | 41 |

*HCFC-224, HCFC-142b are excluded because of negligible use in equipment servicing (see Table 3.1 for consumption).

**Because of the number of small consumers of HCFC-141b, it was not possible to get complete 2006 consumption data.

The impact of phase-out on Thailand's economy has the potential to be significant since HCFC consumption is closely linked to the country's export-oriented, manufacturing base of electronics and refrigeration. Moreover, household consumption, another important indicator of growth in HCFC-based products, has been increasing since 2010. (It will be costly, but it should be expected that the manufacturing and export will continue to grow as per the existing BAU scenario. The real impact of the project will be higher cost of the alternatives to be used in HCFC using products, which eventually will have to be absorbed by the users.) The cost issue has been addressed to ensure conversion of foam sub-sectors with the same phase-out timetables and addressing all air conditioner manufactures in stage 1, combined with a ban on selling new HCFC-22 based air conditioners in the Thai market from 2017.

As per the approved HPMP, the overall HCFC consumption shall be reduced to from 1,155 ODP tons in 2012 to 927.6 ODP tons in 2013, 834.84 ODP tons in 2015 and 788.46 ODP tons in 2018. The reductions will be achieved through a reduction of HCFC-22 consumption of 67.86 ODP tons of HCFC-22 in the air conditioning sector and 151.68 ODP tons of HCFC-141b in the PU foam sector (based on consumption in 2010).

5.3 Investment in HCFC Consumption Reductions in air condition manufacturing sector

Financial support will be provided to foam and air-conditioning enterprises consuming HCFC-141b and HCFC-22 in their production processes. Priority will be given to enterprises established prior to September 2007. The level of support will depend on the documented level of HCFC-141b or HCFC-22 consumption of each individual enterprise and the percentage of the developing country ownership of the said enterprise. The financial support will be used to cover the cost of modification or acquiring new production equipment and related accessories, trial production, raw materials, and technology transfer fees. For Components 1.iii and 1.iv the financial support will determine on the basis of agreed incremental cost defined in the Project Implementation Manual and consistent with the established Executive Committee's funding guidelines.

To apply for financial support, enterprises will be required to submit a project implementation plan delineating the baseline equipment, HCFC-141b consumption, and proof of ownership, established date, and list of new equipment items required for conversion, costs of new raw materials and technology transfer fees and others. The financial agent, appointed by the Government, will review and verify the plan and supporting documents before confirming eligibility of enterprise. The terms and conditions will be stipulated in a sub-grant agreement between the financial agent and each eligible enterprise. In conducting these tasks, the financial agent will be supported by technical and financial consulting teams financed by this project.

5.4 Air-conditioning Sector

Twelve air-conditioning manufacturers with Thai majority ownership will participate in an investment activity to develop, test and introduce an innovative, lower-GWP alternative refrigerant technology in Thailand. The enterprises will receive funding for design, research, development, testing and certification of HFC-32 air-conditioning units. In addition, the project will finance conversion of the production line including replacement of charging equipment, transfer pumps and piping, vacuum pumps, leak detectors, storage of HFC-32, site preparation, production line modification, safety devices, and ventilation systems and other necessary safety costs, technical assistance and technology transfer, trials, training and Multilateral Fund's incremental operating cost. As the conversion will depend on proprietary technology, special attention will be given to help enterprises receive favorable treatment in licensing arrangements and to identify appropriate supply chains for specialized parts. At present, the Japanese manufacturer that owns the patents of HFC-32 air-conditioning technology has already offered to provide all of its basic patents and related training to the twelve local air-conditioning manufacturers participating in the project without royalty's fee.

The refrigerant to be used after conversion will be HFC-32 with zero ODP and a GWP of around 650, which is one third of GWP of HCFC-22. The main changes associated with HFC-32 are the higher pressure of HFC-32 compared to HCFC-22 and its flammability. The change of refrigerant requires redesign and testing of the new air conditioner but provides an opportunity to introduce more energy efficient air conditioners at very limited additional cost. The main cost components associated with the conversion are redesign and testing of the new HFC-32 air conditioners, modification of refrigerant charging lines, i.e. replacement of charging equipment, vacuum pumps, leak testing equipment and safety measures due to the flammability of HFC-32. In addition, new storage area for HFC-32 with HFC-32 transfer pump and piping from the HFC-32 storage to the charging equipment will also be required. Limited funding will be provided to companies with in-house production of heat exchangers for the necessary changes and adjustment in the manufacturing of heat exchangers. Each participating air-conditioner manufacturer will prepare its Environmental Management Plan (EMP).

HFC-32 technology is presently owned by Daikin. Daikin will enter into an agreement with each of the air-conditioner manufacturers on the transfer of technology, free of charge. Japan has also offered to provide technical assistance to the project and the air-conditioner manufacturers.

Availability of HFC-32 compressors and HFC-32 refrigerant has been confirmed during the preparation of the Project. HFC-32 compressors are very similar to R410 compressors presently produced in Thailand. The main difference might be use of motors designed for use of flammable refrigerants. The HFC-32 compressors are expected to be twice the cost of HCFC-22 compressors, but the same cost as R410A compressors. HFC-32 is produced by a number of chemical producers globally. It is expected that the sales price of HFC-32 will be around 15% to 25% higher than that of HCFC-22. However, the amount of HFC-32 used in air-conditioning equipment is around 65% of the amount used in a HCFC-22 air-conditioning equipment of same size. Therefore, the cost impact for servicing HFC-32 air-conditioning equipment will be very limited. From the manufacturing point of view, the less charge size of HFC-32 would enable the manufacturers to redesign smaller sized HFC-32 products when compared to HCFC-22 air-conditioner resulting in less consumption of raw materials. Moreover, the project, will provide financial support to cover incremental operating cost (as defined by the Multilateral Fund) to enable the beneficiary enterprises to remain competitive in the market. As the cost of HFC-32 refrigerant is expected to be around 1/3 of the price of R410A, the use of R410A as refrigerant in air-conditioning equipment would impact the higher service and maintenance cost of air-conditioning equipment when compared to HFC-32.

Table 5-3 : Cost impact of alternative refrigerants

| | HCFC-22 | HFC-32 | R410A |
|---|---------|--------|---------|
| Cost of refrigerant (Baht/kg) | 120 | 150 | 500-600 |
| Charge size compared to HCFC-22 (% of HCFC-22) | 100% | 64% | 80% |
| Compressor cost compared to HCFC-22 (% of HCFC-22) | 100% | 200% | 200% |

5.5 Technical Assistance

For the latter, training by experts in the technology and in servicing in general will be given to trainers at the Department of Skill Development (DSD) and the Office of Vocational Education Commission (VEC) to develop training modules for service technicians for employing good practice in servicing air-conditioning units with flammable refrigerants and for avoiding leakage over time. The Department of Industrial Works (DIW) in close consultation with DSD and VEC will organize training workshops for trainers. Training equipment will be procured and used during the training of the trainers. Handbooks on HFC-32 A/C will be developed and publicized for training purposes.

Towards the latter part of the project, DSD and VEC will begin to roll out training modules in training centers in time for the introduction of HFC-32-based air-conditioning units into the Thai market. The servicing sector work will also include broader curricula to improve in general the servicing practices in the sector in face of reduced supplies of HCFC-22. Technical assistance activities for good practice and safe handling of HFC-32 based equipment will be carried out with bilateral support of the Japanese Government.

For technical assistance with the Department of Alternative Energy Development and Efficiency (DEDE), the project will provide support to DEDE to exclude HCFC-based equipment from the program and to supplement its public awareness program in promoting energy efficient and low GP technology as part of its Green Building Program. A firm will be hired in consultation with DEDE to undertake the activities.

Finally, the project will support the followings technical assistances through the bilateral assistance from the Government of Japan to; (i) provide technical experts for development of safety and performance regulations and standards; (ii) provide technical inputs for development of plant conversion plan (plant layout, process modification, safety plan) and (iii) develop training modules for service technicians for employing good practice in servicing air-conditioning units with flammable refrigerants and for avoiding leakage.

5.6 Environmental Safeguards

The project will also support the followings technical assistances through the bilateral assistance from the Government of Japan to; (i) provide technical experts for development of safety and performance regulations and standards; (ii) provide technical inputs for development of plant conversion plan (plant layout, process modification, safety plan) and (iii) develop training modules for service technicians for employing good practice in servicing air-conditioning units with flammable refrigerants and for avoiding leakage.

The project includes components on investment in HCFC consumption reduction for foam and air-conditioning sectors. For the air-conditioning sector, the investment will finance conversion from HCFC-22 to HFC-32 refrigerant. The investment will provide financing for design, research, development, testing and certification of HFC-32 air-conditioning units.

Phasing out HCFCs usually provides two benefits to the environment: (i) a reduction of global warming gases consumption; and (ii) improved energy efficiency. These types of activities generally have minor to moderate adverse environmental impacts that are specific to each site. Potential impacts and risks include occupational health and safety and fire hazards due to flammability of HFC-32.

The project activities will likely occurs in the existing facility, for which no land acquisition is required. Even though HFC-32 refrigerant will be used, of which, may create safety and occupational health issues. However, these impacts can be mitigated as specified in this Environmental Management Plan (EMP). Therefore, the Project is assigned as an Environment Category B Project and triggers the World Bank's Operational Policy (OP)/Bank Procedure (BP) 4.01 - Environmental Assessment (EA).

These are the common potential problems in the air conditioner manufacturing observed during due diligence site visit as follows (for more detail, please see Annex 5 of the EMP):

- Failures to enforce PPE rules in this particular area;
- Poor arrangement of refrigerant storage area;
- No separation between different type of refrigerant, oxygen, and LPG cylinders;
- Poor manifold, regulators, header, hoses and connectors arrangement;
- Poor method of handling the cylinder. Free standing cylinders always being seen at most sites;
- The area for vacuum and charging located right next to the location where naked flame from brazing is taking place;
- Poor housekeeping as walkways, emergency exit, are blocked, obstructed;
- Lack of safe standard for manifold, valves, and piping labeling;
- Poor maintenance and poor calibration on equipment and tools with standard gas.

In order to identify and mitigate such impacts, a site-specific EMP has been prepared and will be publicly disclosed for each of the total twelve participating manufacturers in the air-conditioning sector. This EMP consists of company baseline information; a due diligence review on current occupational health and safety measures, fire and exposure risk; mitigation measures introduced at the company related to storage and use of HFC-32 in the manufacturing, transport and shipping of air conditioners; emergency response plan, monitoring plan and training needed; estimated budget for the mitigation measures and monitoring; responsibility, time and schedule etc. The final document includes also a summary of the public discussions/disclosure process and any comments raised in link with the possible impacts of the project investments. More details on consultation are described in Section 5.7 and Annex 7 of the EMP.

The EMPs have been prepared and publicly disclosed, in line with the World Bank's Operational Policy (OP)/Bank Procedure (BP) 4.01 - Environmental Assessment (EA) and in accordance with Thai National Laws and Regulations. To the extent relevant, the applicable World Bank Group Environmental Health and Safety Guidelines have been considered in preparing the EMPs.

The implementation of the EMPs will be monitored by the DIW-PMU. The Bank team will periodically conduct supervision missions and provide guidance to the DIW-PMU on the Bank Safeguards requirements.

5.7 Public Consultation

The Project Stakeholder Consultation of Environmental Management Plan (EMP) for the Air-conditioning (AC) Sector under HCFC Phase out Project was organized at the Department of Industrial Works (DIW) on September 6, 2013 during 13.30 pm-16.30 pm. There were 33 participants from concerned agencies attending this consultation workshop. These agencies are 12 AC manufacturing enterprises that will be converting to HFC-32 technology, Air conditioning and Refrigeration Industry Club of the Federation of Thai Industries (FTI), manufacturer of compressor, Daikin Industries (Thailand), Treaties and International Strategies Bureau of DIW, Industrial Cluster 4 Bureau of DIW and the Department of Public Works and Town & Country Planning.

The main objective of this consultation workshop was to present the content and goal of the EMP for 12 AC manufacturers comprising of general risk assessment for AC sector, local regulations applicable for the AC enterprises, local regulations specific for HFC-32 refrigerant and proposed mitigation measures for the conversion from HCFC-22 to HFC-32 refrigerant.

More details of the consultation and stakeholders recommendations are provided in Annex 7. Key recommendations are summarized as follows:

- To allow the enterprise to meet safety requirement to ensure safety of the conversion to HFC-32 technology, the reallocation of funding from other component will be discussed with the enterprises and reflected in the Project Implementation Manual (PIM);

- Awareness to pay attention to the transportation of finished products to the end user's site will be addressed through training of RAC technicians and the enterprise's training program;
- A site visit to Daikin Industries (Thailand), which would help the enterprises to understand the plant layout and safety measures put in place for the use of HFC-32 will be conducted before the conversion take place;

6. Legal and Regulatory Framework Requirements

6.1 General Provisions of Air-conditioner Manufacturing Enterprise

This section is only to highlight the laws and regulation that relevant to processes, activities in production of air conditioner. The name of the laws or regulation mentioned in this section is intended for pointing out a very minimum safety, health and environmental requirements and standards that the enterprises should always comply in order to ensure that the potential hazards and risks have been controlled at a minimum, reasonably and practically acceptable level. The air conditioner manufacturing enterprises participating in the HCFC phase-out project must comply with all relevant safety, environmental and occupational health provisions in applicable national and local laws and regulations. There are a number of Safety, Occupational health, workplace environment, chemical and substances handling, storage, and transportation and so on that pertain to all kind of industry in Thailand. The ways that laws and regulatory requirements are enforced are through; licensing and permission control, inspection and reporting by the appointed inspectors, and the mandatory requirements for the enterprise to establish in-house management systems and report back to the governing authority on regular basis.

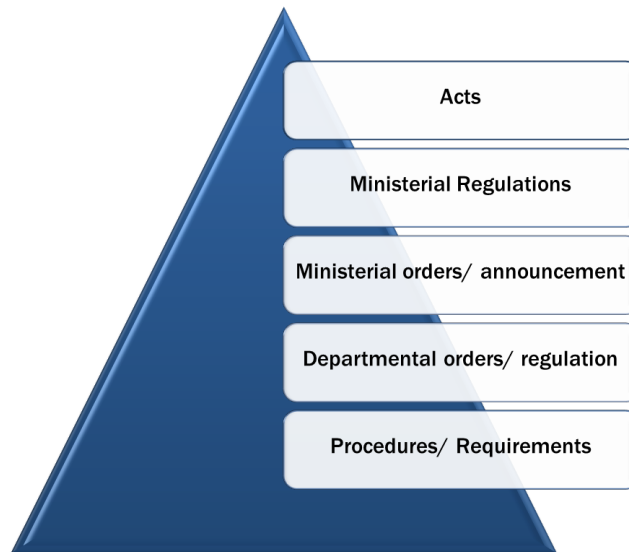


Figure 6-1 Illustration of the hierarchy of Laws and regulations in Thailand

Factory Act B.E. 2535 (1992)

This act is empowered Ministry of Industry to regulate and make sure that industrial sector in Thailand are built their factory building and utilities, install machineries and equipment, operate their production in a way that causes no harm to workers, community and environment. To achieve that general aim, the authority uses their power through the process of granting licenses to the enterprises.

Chapter 1 “Engagement in a Factory Business” Section 7 The Minister shall have the power to prescribe the ministerial rules fixing the factory of any type, kind or size to be the group 1 factory,

group 2 factory, or group 3 factory as the case may be by taking into consideration the necessity for the control, prevention of nuisance, prevention of damage, and prevention of danger in accordance with the gravity of impact on the public or environment by classifying as follows

- Group 1 factory are such factory of the type, kind and size as capable of engaging in a factory business immediately upon desire of a person engaging in a factory business. Group 2 factory are such factory of the type, kind, and size as, when engaging in a factory business, must be notified in advance to the Grantor.
- Group 3 factory are such factory of the type, kind, and size as to be granted a permit prior to the engagement.

Due to the high horse power of the machines in the factory, air conditioner manufacturing factories are classified as Group 3 Factory. Therefore, all participant of the HPMP Stage 1 project must have the current and valid factory license. Section 8 of the Factory Act B.E. 2535 (1992) empowered the Minister of Ministry of Industry to issue the ministerial rules which any or all groups of factory under Section 7 must comply with respect to ensuring that the criteria relating to the location of factory, environment of the factory, the nature of the building- in another word, safety of the building are satisfied. On this section, Item (8) also mention the requirement for having safe operations in order to prevent or stop or mitigate the dangers or injuries that may result from the engagement in a factory business. Therefore, all air conditioner manufacturing factory who are licensed to operate shall have safe building and structure, ensure that machineries and equipment are installed and operated in a safe manner, by using proper trained and qualified workers, and fulfill the requirements to have protection against injury and illness.

Although, Section 1 clause 18 (1) of Factory Act B.E. 2535 (1992) is all about renewal of the factory license and the permission for expansion or making modification of the factory building, increasing the capacity of the machineries. Assumably, the fundamental criteria to grant a renewed license to any group 3 factories, the authority should take into his or her consideration that the compliance to the previous sections that require safe building, well protected from fire and explosion, safe working conditions, proper guarded machines, good electrical set up, no fire or explosion risk, etc.

The enterprise participating in this HPMP stage 1 must have the current license for utilization of factory building and the inspection recorded issued by the local authority in accordance with Building Act B.E. 2522 (1979). Although, there is no direct statement on this particular law about safe building, having fire protection system, installing the right type of electrical equipment, etc. the licensing process totally relies on an authorized inspector to grant a permission for occupying a building. On clause 8 of this law set a general requirement toward the authority to ensure that the building are safe, fire protection are adequate, electrical, gas and all kind of utilities are installed at safe standards.

The requirement regarding fire prevention/ protection had been revisited seriously after a disaster in a toy factory in B.E. 2535 (1992) that claimed many lives. Fire prevention and control Act. B.E. 2542 (1999) issued by Ministry of Interior in responding to that incident. This act, define meaning of the term; "Fire prevention" and "Fire control" on clause 4. The detail of this act aims to empower the local authorities to have the power to make suggestion to the owner of any building to meet "General standards for prevention and control fire".

Notification of the Ministry of Industrial Subject: Factory Fire Prevention and Control B.E. 2552 (2009) issued by the Ministry of Industry, enacted by the Factory Act B.E. 2535 (1992), Chapter 1 General, Item (3) define the meaning of the factory that is high risk of fire (48 types of factories) and the meaning of the factory that medium risk of fire (other type of factories). Air conditioner manufacturers are classified as factory type of 70, 71, which are not listed in the ministerial order as factory having the high risk of fire. Therefore, air conditioner manufacturers are classified as the factory having medium risk of fire. However, this regulation provides general guidance for providing ADEQUATE fire protection system including detection and alarm system, portable fire extinguishers, (only this part that relevant to classified fire risk), fire water, and sprinkler. This regulation also suggests periodic inspection, testing and maintenance on the fire protection system, establishment of fire emergency plan, setting up evacuation plans, providing training for the employee, and maintains test records for inspection by the authority.

In general the enterprises are obligated to ensure safe workplace as defined by the clause 4 and 6 of Occupational Safety, Health and Environment Act B.E. 2554 (2011), which was issued by Ministry of Labor and Welfare. Interestingly, this act does not mention fire, or any hazardous material, gases, or electrical, etc. in particular. The law generally define the meaning of the term; "Safety, Occupational Health, and working environment means actions or working conditions that free from endangering to life and death, physical harm, mental harm, affect to health due to working environment". The employer is responsible for providing safe, working environment to protect workers from the said "Harm". Therefore, the expectation toward the air conditioner factory owners is to prevent their workers from fire hazards as well as the other types of hazards. The law also requires employer to formulate management plans to ensure the safe workplace is provided.

These are also defined repetitively by different laws and regulation such as, Notification of the Ministry of Industrial Subject: Factory Fire Prevention and Control B.E. 2552 (2009), Ministerial Regulation of Social welfare and labor protection Ministry subject Establishment standard of Safety, Health and Working environmental management system for fire prevention and control B.E. 2555 (2012).

Safe working places minimum safety standard in relation to building and facility arrangement includes Safe access and egress shall be provided for personnel during normal and emergency conditions, including appropriate entry and exit from the building or structure, designated working areas, common areas, emergency assembly area. The layout and condition of buildings and structures are designed and maintained to eliminate or effectively control ergonomic risks, manual handling risks, exposure to noise, exposure to atmospheric contaminants or hazardous substances, such as lubricants, coolants and cutting fluids that used generally in metal workshop and also in coil/heat exchanger production shop floor. Exposure to extreme temperatures such as powder coating heat treatment oven have to be annually monitored and report the result to the Department of Labor protection and Welfare. Housekeeping standards are communicated and maintained, including arrangements for: safely storing tools, equipment and materials when not in use ensuring that passageways, pathways, aisles, emergency exits and equipment are not obstructed maintaining the cleanliness of work areas and amenities identifying and removing any slip and trip hazards.

Plant equipment, machineries safety

Air conditioner manufacturing factory should have and maintain their plant equipment, machineries, in a safe condition. (Installed, operated, maintained in accordance with acceptable standards).

Shall meet the requirement as stated on the Section 1 clause 18 (2) of Factory Act B.E. 2535 (1992). Same as discussed above, to grant a renewal or expansion permit or license, the authority shall come across to the judgments if such a changes made at any factory are in safe and meet recognized standards. The illegal expansion of the building without making sure that the basement and the structure of the building can take the increasing load can cause the accident from floor collapsing.

Occupational, Health and Safety Acts B.E. 2554 (2011) Section 4 clause 32 and set out specific safety requirements that the employer of the workplace shall establish a hazard identification and a risk assessment process for all existing plant and equipment in use at the workplace. Machineries, plant equipment are determined as workplace environment where the workers have to work nearby, work on them, stand on them, put their hands and fingers into them, therefore it is regulated under this act with no doubt.

Ministerial Regulation of Occupation Safety, Health and Environmental Standards for Machinery, Crane and Boiler B.E. 2552 (2009), sub section 1, 2 and 3 relevant to plant equipment safety that requires lock out tag out procedures, testing and recording the critical parts of them.

An appropriate site based plant and equipment database shall be developed and maintained. A Plant and Equipment Risk Assessment shall be undertaken prior to purchasing any new plant and equipment, and during the design or modification of plant and equipment. In addition, the Plant and Equipment Design/Modification Hazard Identification shall be completed. The implication of the mentioned requirement is that the enterprises who are converting there refrigerant from HCFC to HFC-32 in the process, either changing machine, equipment, using new refrigerants , altering

production process/ task are required to update their identification and risk assessment then submit to the local authority.

International recognized best safety practices regarding plant equipment and machineries suggest, adequate maintenance program that includes inspections, maintenance and cleaning shall be Standard Operating Procedures (SOPs) shall be developed for all medium-to high-risk tasks that are associated with the use, adjustment, cleaning, repair or maintenance of any plant and equipment especially those associated with metering, pumping, and charging refrigerant. There is workplace regulation that specifically requires the employer to establish SOPs and provide adequate training to their worker which is Ministerial regulation B.E. 2549 (2006) Subject: Establishment of management system for safety, occupational health and working environment. All plant and equipment that poses a mechanical/electrical hydraulic pneumatic or kinetic hazard shall be appropriately guarded. This is clearly defined by Section 1 clause 4 of Occupational, Health and Safety Acts B.E. 2554 (2011). All personnel using plant and equipment shall be equipped with suitable Personal Protective Equipment (PPE). All unsafe plant and equipment shall be identified and quarantined or withdrawn from service.

Electrical system inspection and maintenance

Occupational Safety, Health and Environment Act B.E. 2554 (2011) as mentioned earlier that this act said no word about electrical but very unfortunate that electricity can kill people. Therefore it is a hazards in a workplace and shall be provided in safe condition by the employer.

Ministerial Regulation of Occupation Safety, Health and Environmental Standards for Electrical System B.E. 2554 (2011), provide better detail regarding electrical safety such as detail on;

Section 1: General

Section 2: Electrical Apparatus

Section 3: Lightning Protection

Section 4: Personal Protective Equipment and Safety Devices or Equipment for Prevention electrical hazards

Ministerial Regulation B.E. 2550 (2007) Industrial Electrical standard set out specific electrical safety requirements that every workplace shall enforce in order to meet their legal responsibility of providing a safe working environment in all workplaces.

Health and hygiene

There are specific workplace health and safety requirements that pertain to all enterprise.

Occupational Safety, Health and Environment Act B.E. 2554 (2011) and Requirements under Ministerial Regulation on the Prescribing of Criteria and Method of Conducting Health Checkup of Employees and Forwarding the results of health checkup to labor inspector B.E. 2547 (2004) by Ministry of Labor and Welfare issued by Ministry of Labor and welfare, Chapter 1, Item 1 set out specific health surveillance requirements that every workplace shall enforce in order to meet their legal responsibility of providing a safe working environment. The following minimum mandatory requirements shall be implemented to ensure workplace compliance in relation to health surveillance: Prospective employees and relevant contractors shall participate in a pre-placement medical assessment using the Pre- and Post-Placement Health Assessment, Health assessments shall be conducted regularly for all employees involved in driving forklift, transportation of the products, off-site technical support team, etc.

Emergency response;

Notification of the Ministry of Industrial Subject: Factory Fire Prevention and Control B.E. 2552 (2009) issued by the Ministry of Industry, enacted by the Factory Act B.E. 2535 (1992) Chapter 7 require fire prevention and control training for the employee to be provided on annual basis. Although this law says not thing about "Emergency Response" but the intention of training people to know what to do when they see a fire, how to use portable fire extinguisher, and where to go when they have to evacuate.

Ministerial Regulation B.E.2555 (2012), Establishment of management system for safety, occupational health and working environment – Fire prevention and control clause 30 requires the workplace to have effective emergency response plans. This law does not specify that the workplace must have emergency plan for LPG leak, an emergency plan for HFC-32 leak, fire from glue painting, etc. It is the responsibility of management to think what scope of their emergency response plan should be.

For the potential cases such as the uncontrolled release of LPG gas and the spill or leakage of chemical, the safe workplace and laws and regulations that specify the need to have adequate fire protection equipment have been mentioned earlier. In addition, there are needs for proper maintenance and inspection of firefighting, arrangement of fire emergency plans and evacuation drills. Moreover, best industrial standard practices suggest that;

“The site manager or their delegate shall identify Potential emergency situations on, or in the vicinity of, the workplace and develop a Site Emergency Response Plan. Emergency procedures are documented and regularly reviewed. Each workplace shall have an established communications system that allows effective communication. Each workplace shall establish immediately available internal and external emergency contact details. The site manager or their delegate shall allocate overall responsibility for the control of emergency situations to specific individuals, and shall communicate this information to all employees by completing and displaying the Emergency Response Contacts. Competent personnel shall assess the suitability, location and accessibility of emergency equipment. Emergency and fire-protection equipment, exit signs and alarm systems shall be regularly inspected, tested and maintained.”

Where required, LPG, and HFC-32 are classified as hazardous substances, manifests or registers shall be established and shall comply with legislative requirements issued by the Department of Industrial Works - Land transportation of hazardous substance B.E. 2546 (2003). First aid requirements shall be assessed, and the first aid system shall be appropriate to the operational risks.

Discharge, emission, and Waste management shall meet minimum requirement as stated on the Section 1 clause 8 (5) of Factory Act B.E. 2535 (1992) requires that the licensed factories shall always comply with the established standard for discharging waste, emitting pollution, or causing environmental impact to the surrounding area.

In general, air conditioner production process does not generate waste water and emission of air contaminants directly except the factory that has pre-treatment process of the metal parts for powder coating. The enterprises, however, shall ensure that there is a well control of the storage area where chemicals used in metal cleaning process, oil, lubricant; liquid solvent based glue, etc. are stored properly to avoid spills and leakage incidents.

As mentioned above that spill and leakage handling procedures shall be established. The arrangement of secondary containment around those areas is required. Ministry of Industry has issued a ministerial order number 2 B.E. 2539 (1996) subject discharged waste water standard criteria that have to be always complying. In the air condition factory that has waste water from metal cleaning pits, water curtain paint booth is to ensure the quality of discharged effluent always within the limits.

There is an Notification the Department of Social Welfare and Labor Protection, Ministry of Labor and Welfare subject Guidance for transportation, storage, handling and disposal of chemical and hazardous substance packages B.E. 2535 (1992), item 12, and also the disposal of solid waste and unused material from the air conditioner factory shall meet requirement specified by the Ministry of Industry order B.E. 2548 (2005) subject Disposal of debris and unused material (issued by Ministry of Industry). To always comply with this regulation it is suggested that the enterprises to arrange for;

- Waste storage area where segregate non-hazardous waste and hazardous waste.
- Labeling empty drums of chemical, oil, lubricants to prevent unexpected accident or misused if those chemical containers are to be taken by scrap buyer.
- Inspections and ensure that there is no contamination to soil, and water
- manifesting document shall be kept and available for inspection by the authority
- Record-keeping; and Reporting requirements.

Annex 6 summarizes lists of national laws and regulations for air-conditioning sector enterprises under HPMP Stage I.

6.2 Specific Safety Provisions Regarding HFC-32

Table 6-2 Reference: ANSI/ASHRAE Standard 34-2010 -Refrigerant Data and Safety Classification

| Refrigerant number | Chemical name | Chemical formula | Molecular mass | Boiling point °C | Boiling point °F | Safety Group | Highly or under classification | Toxic code |
|--------------------|--------------------------------------|------------------------------------|----------------|------------------|------------------|--------------|--------------------------------|------------|
| 22 | dichlorodifluoromethane | CHClF ₂ | 86.5 | -41 | -41 | A1 | Neither | |
| 32 | Difluoromethane (methylene fluoride) | CH ₂ F ₂ | 52.0 | -52 | -62 | A2L | Neither | |
| 141b | 1,1-dichloro-fluoroethane | CH ₃ CCl ₂ F | 117.0 | 32 | 90 | | Neither | |

HCFC-22 has been classified under Safety Group A1 based on the test result that indicates two characteristic; no flame propagation and lower toxicity

HFC-32 has been classified under Safety Group A2L because it is Lower flammability and Lower toxicity refrigerant with a maximum burning velocity of less than or equal 10 cm. per second. HFC-32 may cause flash fire and be harmful if swallowed. The direct contact of HFC-32 can be harmful to skin. Information below indicated safety data for HFC-32. More detail can be found in Annex 3.

Safety Data for HFC-32

Difluoromethane CAS NO. 75-45-6
 US DOT PROPER SHIPPING NAME: Difluoromethane
 US DOT HAZARD CLASS: 2.1 – Flammable Gas
 US DOT PACKING GROUP: Not applicable
 US DOT ID NUMBER: UN 3252

Also known as Methylene fluoride; Carbon fluoride hydride (CF₂H₂); Difluoromethane; Freon 32; Genetron 32; Methylene difluoride; CH₂F₂; R 32

Physical property:

This refrigerant is delivered in a cylinder as it is liquefied gas.

Flammable limits: Lower =14% Upper = 31%

Heavier than air 3.82

The given information above indicates HFC-32, when it released from the container and enter to the atmosphere, it will be turned to gas phase instantly because of very low flash point at below -40 degree C. When it mix with the air around the area of leaking, the first lowest concentration that the air mixture can be ignited is 14%. The general condition of refrigerant charging procedure has very low likelihood of HFC-32 to be released uncontrollable and reach the lower flammable limit. However, in the event that HFC-32 may leak out due to failure of connections, hose ruptures, the possibility to have HFC and air mixture at the level of lower flammable limit is likely. Well designed, and maintained equipment used in charging process will minimize the likelihood of uncontrolled release of HFC-32. On the other hand, poor connection, under specification hoses, seal and connector and combination with incompetent and unskilled worker who perform the task may increase the likelihood of leakage of HFC-32. In this case, the risk of fire in the charging area is increased.

The air-HFC32 mixture can cause flash fire. Because of the HFC-32 is almost 4 times heavier than air. When it leak, the gas can travel along the lower area such as sump pit, drainage and find the way to be ignited by the ignition sources away from the location where it leak. The fire will flash back into the source of leaking and burn vigorously. Ventilation in the area where HFC-32 is stored, handled and used is critical.

Auto-Ignition temperature of HFC-32 is 647 degree C. At this temperature, the naked flame from brazing torch used at the assembly line nearby or a small arc from electrical sockets due to poor installation can simply ignite the flammable atmosphere.

The additional safeguards to put in place before HFC-32 is to be used therefore including;

1. Redesign of work area to keep distance where HFC-32 is used and the area where ignition sources from the adjacent process.
2. Redesign of storage facility. See more detail on Item 7.2 Safety criteria for the construction of storage facility for HFC-32. The use of electric fans from the ceiling, ventilation exhaust fans on the wall are example of the term "General ventilation".
3. Installation of the Ex-Proof electrical equipment in the storage area, production line around HFC-32 refrigerant charging, vacuum and also the electrical used in performance test labs.
4. Ex-proof type of transfer pumps, vacuum pumps, charging machines, and piping are required.
5. Ventilation system – general ventilation and local ventilation at the charging station. Because of HFC-32 is heavier than air, it tends to accumulate near the ground level. Well-ventilated area will eliminate the likelihood of HFC-32 in the air at lower flammable limit which can be ignited by the ignition sources. Generally, ventilation can be classified into two types; first is natural ventilation which is mainly benefit from building design and construction to have air movement naturally and no need additional mechanical devices, and second is artificial ventilation. This type requires mechanical devices such as exhaust fan, hood and ducts. General ventilation is simple way to induce air movement in the building. The term "Local exhaust ventilation (LEV)" is a ventilation system consisting of hood to capture air contaminants at the source of generation and move it through the duct. The exhaust fan creates suction at the face of the hood and make the air contaminant to be ventilated away. For more detail, please refer chapter 3 of "The manual for inspection, installation of electrical system in a factory where volatile flammable substance are used". This manual was issued by the Office of Safety Technology, Department of Industrial Works, Ministry of Industry, June B.E.2548.
6. Gas detection and alarm system is recommended to be installed at;
 - a. HFC-32 storage area
 - b. Refrigerant charging area
 - c. Vacuum area
 - d. Finish good warehouse

Flammable gas detectors can make a valuable contribution to the safety of these processes. They can be used to trigger alarms if a specified concentration of the gas or vapor is exceeded. This can provide an early warning of a problem and help to ensure people's safety. However, a detector does not prevent leaks occurring or indicate what action should be taken. It is not a substitute for safe working practices and maintenance.

Detectors can be fixed, portable or transportable. It is recommended to have 'fixed' detectors, permanently installed in a location mentioned above to provide continuous monitoring of HFC-32. The components of a gas detection system include sensors, control unit and alarm. The position of the detection sensors for HFC-32 should be at the low level above ground surface due the fact that HFC-32 is heavier than air and tend to accumulate there. The control unit or control panel of detection system should be located outside of the hazardous zone. The alarm should be installed at the locations mentioned above and at the

location where general area can be alerted. It is also recommended that the alarm should be installed at security guard house.

7. Redesign or improvement on fire protection is required. Especially when large volume of container like 1 ton is to be stored, adequate fire water for cooling gas container to prevent Boiling Liquid Expanding Vapor Explosion (BLEVE).
8. Reviewing of fire emergency response plan shall be done to ensure that the local fire department is familiar with fire at the compressed gas cylinders. Fire water cooling system shall be redesigned to cover HFC-32 storage area.
9. Training of the workers who handling HFC-32 to be aware of its physical properties, flammability, immediate health hazards and personal protective equipment to be used.

Table 6-3 Summary of Laws and Regulations for Converting to HFC-32

| Concerned Processes/Chemicals | Name of Laws / Regulations | Brief Description of Laws / Regulations |
|--|---|---|
| Storage facility design and construction for HFC-32 | Hazardous Substance Act B.E. 2535 DIW Notification on Storage of Chemical and Hazardous Substances B.E. 2550 | Criteria for construction chemical and hazardous substance storage facility. Fire rating of the wall, roof, and floor is determined under this regulation. Safety equipment such as emergency light, grounding, bonding requirement are specified. Fire protection and extinguisher is specified by this regulation. |
| Workplace health and safety requirement that require additional SOP, training and protection for the worker who expose to HFC-32 to ensure that the fire hazards is always recognized. | Ministerial regulation B.E. 2549 Subject: Establishment of management system for safety, occupational health and working environment. | Section 1 Item 5 Standard Operating Procedure has to be revised. The workers who are to be assigned to work on new equipment, new processes, and exposure to new chemical have to be trained and be competent. |
| Revise emergency response plan | Ministerial regulation B.E. 2555 Subject: Establishment of management system for safety, occupational health and working environment, Fire prevention and control | Section 1 Item 2 The emergency response plan shall be revised to cover possible scenario of HFC-32 uncontrolled release, spill and leakage handling procedure. Section 1 Item 6 Update SOP and provide additional training for the employee so that they are fully aware off the additional fire hazard from handling HFC-32 |

7. Proposed Mitigation Measures

The following proposed mitigation measures are made to the enterprises participating in the HPMP Stage 1 project to take into consideration to implement in addition to existing programs. Some of these mitigations are prescribed by Thai laws and regulations, some of them are considered recognized best practices among the industrial sectors.

7.1 Building and Structure

Safe access and egress shall be provided for personnel during normal and emergency conditions, including appropriate entry and exit from the building. Good housekeeping should be maintained in the area near the plastic injection to ensure no plastic is jammed inside the more and catch on fire. The designated walkway shall be kept clear.

Management shall assess the security risks for all permanent and temporary places of work prior to use and after significant structural or layout changes have been made. Potential security controls include restricted access (e.g. by using fences, gates, locks or electronic card entry), the presence of security personnel, alarms, CCTV cameras, adequate lighting and signage. When practicable, buildings and structures shall be designed so that access to certain areas can be restricted to authorized personnel. It is recommended that the area where HFC-32 to be stored, LPG tanks, and the storage of Oxygen cylinders are sensitive and require security control. CCTV or regular patrol by security guard is suggested.

The layout and condition of buildings and structures are designed and maintained to eliminate or effectively control ergonomic risks, manual handling risks, exposure to noise, exposure to atmospheric contaminants or hazardous substances, exposure to extreme temperatures, slips, trips and falls, spills and leaks, fire and explosion and falling objects.

Use adequate protection from fire and explosion as required by laws and regulations. Managers shall ensure that established housekeeping standards are communicated and maintained, including arrangements for: safely storing tools, equipment and materials when not in use ensuring that passageways, pathways, aisles, emergency exits and equipment are not obstructed maintaining the cleanliness of work areas and amenities identifying and removing any slip and trip hazards.

7.2 Safety Criteria for Construction of Storage Facility for HFC-32

The following guidelines has been developed and announced by the Department of Industrial Works. DIW Notification on Storage of Chemical and Hazardous Substances B.E. 2550 is available for download at the website <http://eis.diw.go.th/haz/hazard/pdf/pagad-kep-2550.pdf>

This guideline should be applied for the air conditioner manufacturing company who are seeking for instruction to make the storage facility for HFC-32 and other compressed gases, chemicals used in their facility safe.

Table 7-1 Guidelines should be applied for the air conditioner manufacturing company for storage facility for HFC-32 and other compressed gases and chemicals.

| Structures | Guidelines |
|--|---|
| Building wall, compartment and fire wall | Wall/ compartment must be fire resistant material. Width and height of the fire wall has been defined by this guideline (Section 2 Storage Facility item 2.1) The air conditioner plant that plan to build new storage room for HFC-32 must be aware that the new building which is located near the other building in 10 meter distance, the wall and compartment must be capable of fire resistant for at least 3 hours. (in case that the storage facility is used for flammable material) Storage area for compressed gases including HFC-32 shall be under the roof to prevent exposure directly to sun light. |

| Structures | Guidelines |
|-------------------------------|---|
| | To maintain good ventilation, solid wall is not recommended. |
| Floor | Specific requirement for the floor of storage room for HFC-32 is conductive floor to prevent electro static charge. There should have no pits or drainage near the area where HFC-32 is stored. |
| Doors ways and emergency exit | The storage room must have at least 2 doors for entrance and exit. The size of the door must meet design criteria. Emergency light, safety signs are required. |
| Roof | Fire resistant at least 30 minutes |
| Ventilation system | Required and must meet specified criteria. |
| Electrical system | Meet Engineering design criteria specified by the Thailand Engineering Association. HFC-32 storage room requires meeting Explosion Proof type and electrostatic charge protection, grounding. |
| Emergency lighting | Required at least at doors and exit. |
| Electrical appliances | HFC-32 storage room requires to meet Explosion proof type and electrostatic charge protection, grounding |
| Lightning protection | Building near the storage room in the distance 30 meter must have lightning system. The design must meet Engineering design criteria specified by the Thailand Engineering Association. |
| Detection and alarm system | Detectors can be fixed, portable or transportable. It is recommended to have 'fixed' detectors, permanently installed in a location mentioned above to provide continuous monitoring of HFC-32. The components of a gas detection system include sensors, control unit and alarm. The position of the detection sensors for HFC-32 should be at the low level above ground surface due the fact that HFC-32 is heavier than air and tend to accumulate there. The control unit or control panel of detection system should be located outside of the hazardous zone. The alarm should be installed at the locations mentioned above and at the location where general area can be alerted. It is also recommended that the alarm should be installed at security guard house. |
| Fire protection system | Fire extinguishers, portable or fixed system. |
| Fire water | Must have adequate fire water based on the size of storage facility. LPG and HFC-32 storage tanks can explode in case of fire. Cooling storage tanks with sufficient of water is to prevent Boiling Liquid Expanding Vapor Explosion. |

7.3 Plant Equipment, Machineries Hazard Identification and Risk Management.

Hazards review of process equipment for either new or existing facilities. Occupational, Health and Safety laws and Regulations set out specific safety requirements for all power-operated plant and equipment that every workplace shall enforce in order to meet their legal responsibility of providing a safe working environment. The following minimum mandatory requirements shall be implemented to ensure workplace compliance in relation to plant and equipment:

The Site/Operations Manager or their delegate shall establish hazard identification and a risk assessment process for all existing plant and equipment in use at the workplace. An appropriate site based plant and equipment database shall be developed and maintained. A Plant and Equipment Risk Assessment shall be undertaken prior to purchasing any new plant and equipment, and during the design or modification of plant and equipment. In addition, the Plant and Equipment Design/Modification Hazard Identification shall be completed. Consultation shall occur with relevant employee representatives when conducting plant and equipment risk assessments. A maintenance program that includes inspections, maintenance and cleaning shall be established for plant. Safe Work Method Statement (SWMSs) and site Standard Operating Procedures (SOPs) shall be

developed for all medium-to high-risk tasks that are associated with the use, adjustment, cleaning, repair or maintenance of any plant and equipment. All plant and equipment shall be registered where required by legislation or the regulated governing body. All plant and equipment that poses a mechanical/electrical hydraulic pneumatic or kinetic hazard shall be appropriately guarded. All personnel using plant and equipment shall be equipped with suitable Personal Protective Equipment (PPE). All unsafe plant and equipment shall be identified and quarantined or withdrawn from service.

Appropriate induction and training, including high-risk training, shall be provided where required.

7.4 Electrical System Inspection and Maintenance

Occupational, Health and Safety standards set out specific electrical safety requirements that every workplace shall enforce in order to meet their legal responsibility of providing a safe working environment in all Air conditioner production plant workplaces. The following minimum mandatory requirements shall be implemented to ensure workplace compliance in relation to electrical safety:

All electrical work, equipment and materials shall fully comply with regulated Thai and recognized Industrial Standards, Local Regulations and this EMP.

All electrical equipment and materials shall be fit for their intended purpose and the environment in which they are being applied.

Electrical work shall only be undertaken by: Licensed Electricians. All electrical work must be supervised by a licensed Electrician with an Electrical Supervisors Qualification (A Qualified Electrical Supervisor can supervise themselves).

Site/Operation Manager shall ensure that all electrical personnel are aware of the “No Live Electrical Work” rule

7.5 Mobile Plant Equipment Inspection and Maintenance

To prevent accident during transporting refrigerant from one location to the other location;

All operators shall be assessed as competent and hold a current statutory license for the mobile plant that they operate where such a license is required. Competency re assessments shall be undertaken every two years.

Employees shall complete a Mobile Plant and Vehicle Pre-Start Check prior to using mobile plant for each shift, and this shall be retained by the Front Line Supervisor.

The selection, purchasing, leasing or hiring process for mobile plant shall include a thorough risk assessment to ensure that the vehicle is fit for its intended purpose.

Standard Operating Procedures that cover all aspects of a mobile plant's operational use and maintenance activities shall be developed.

7.6 Standard Operating Procedures and Safe Work Method Statement

The purpose of this Standard Operating Procedure (SOP) is to develop and maintain safe systems of work for persons responsible for the use and handling of compressed oxygen, LPG gas, Refrigerant cylinders and pressure vessels associated with the air condition making process. Refer to DIW Notification on Storage of Chemical and Hazardous Substances B.E. 2550 and Ministerial Regulation of Occupation Safety, Health and Environmental Standards B.E. 2549, chapter 1, item 3.

Pressure equipment Regulated air receivers covered by (other than gas cylinders) shall be inspected, operated and maintained.

7.7 Accident Reporting and Investigation Procedure

Refer to:

- Occupational Safety, Health and Environment Act B.E. 2554 by Ministry of Labor and Welfare, Chapter 4, clause 34, reporting of incident.
- Ministerial Regulation of Occupation Safety, Health and Environmental Standards B.E. 2549, chapter 1 General, roles and responsibilities of appointed safety officers.
- Notification of Welfare and Labor Department B.E. 2549 Criteria and procedures for appointment of safety officer and reporting employee accident, injury/illness and lost.
- Notification of Welfare and Labor Department B.E. 2554 Reporting template for major incident or work related accident.

It is the obligation of management and designated personnel required by laws to have standard management system that cover reporting and investigation incident in the workplace.

Any person involved in or close to any incident, shall notify the site/operations manager or supervisor. The site/operations manager or supervisor shall, as far as is reasonably practicable, make the area of any incident safe and prevent further escalation. Immediate first aid, medical and other assistance shall be provided to any injured person.

The site/operations manager or their delegate shall ensure that all relevant persons are informed of the incident in accordance with the incident consequence rating.

The scene of an incident, where appropriate, shall be secured for incident investigation purposes. All incidents shall be reported to management and communicated in accordance with their consequence rating.

All incidents shall be recorded.

All incidents shall be investigated by a team, which is formed in accordance with the incident consequence rating.

The investigation team shall identify the corrective actions required to prevent a re-occurrence of the incident, using controls selected in descending order from the Hierarchy of Control.

7.8 Permit To Work Procedures

The hazards, risks and controls associated with a particular task shall be identified, assessed and understood by those carrying out the work. Risk control measures shall be developed and implemented. For example, a group of maintenance and out-sourced contractor are about to remove a section of roller conveyor near the refrigerant charging area. The tasks they are going to perform generate ignition sources from cutting, grinding and welding. In this example situation; the interactions between maintenance work, construction work and plant operations shall be safely managed. All personnel either issuing or receiving a Permit to Work shall be authorized to fulfill that role. The critical roles are, to be someone who gives permission and to be someone who receives permission. These does not means to create new position or to hire additional man power. It is the working procedure that nobody should just bring the tools and start working then causing fire and explosion in the production area without any controls.

7.9 Warehouse and Storage Facilities Management, Hazardous Material Handling and Storage

Hazardous Substances Act B.E. 2535 and Regulations set out specific safety requirements for hazardous substances and dangerous goods that every workplace shall enforce in order to meet their legal responsibility of providing a safe working environment. The following minimum mandatory requirements shall be implemented to ensure Air conditioner production plant workplace compliance in relation to hazardous substances and dangerous goods:

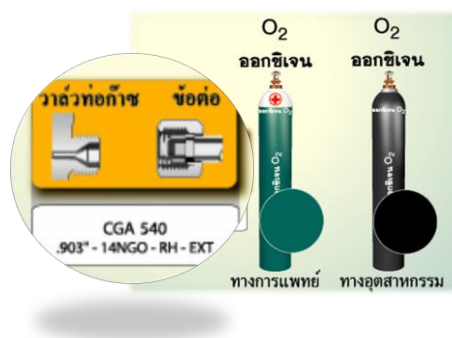
There are specific regulation related to the qualification of workers who involve in receiving, unloading, handling and storage of compressed gases used in air conditioner production factory that need to be complied. (Ministerial order of Ministry of Industry Subject Safety measurements for the workplaces where production, storage, compression, use, and transportation of gases B.E. 2548)

DIW Notification on Storage of Chemical and Hazardous Substances B.E. 2550 is set out clear guidelines to handle not only chemical but flammable gases including HFC-32.

Adequate storage shall be provided for hazardous substances, which may include suitable containers, adequate segregations and separation and loss containment.

Containers, tanks, pipes, plant and storage areas associated with hazardous substances and dangerous goods shall be clearly and appropriately labeled.

The suppliers of refrigerants, LPG, N2 and Oxygen shall be carefully selected and ensure that the compressed gases purchased and used in air conditioner production always meet the safety standards specified by authority.



Example of Referenced standard:

- TIS 88-2517 Color code for Industrial gas cylinders
- TIS 255-2517 Safety devices on compressed gas cylinder
- TIS 358-2521 Use and maintenance of the compressed gas cylinders
- TIS 359-2523 Seamless compressed gas cylinder
- TIS 541-2545 Oxygen gas Industrial.

A Hazardous Substance Risk Assessment shall be conducted to identify the hazards involved with the use of each hazardous substance or dangerous goods, and the likelihood of these hazards causing injury or harm.

Material Safety Data Sheets (MSDSs) shall be obtained for all hazardous substances and made available to all employees in hard copy as a minimum.

All employees shall be trained in using and handling Hazardous Substances. Personal Protective Equipment (PPE) appropriate and necessary for handling hazardous substances and dangerous goods shall be provided and maintained in good condition.



Adequate first aid facilities appropriate to the hazards associated with hazardous substances shall be readily available.

Warehouses should be designed and laid out to allow for the safe movement of goods, materials and people. The warehouse design and layout should consider:

Storage areas and the appropriate width of aisles and gangways

- slip, trip and fall hazards
- pedestrian and vehicle traffic routes and turning circles
- staircases and ramps
- lighting
- ventilation
- blind spots
- emergency escape routes
- speed limits
- Surface type, condition, camber and slope.

Information about the warehouse design and layout should be included in the Traffic Management Plan

7.10 Transportation and Traffic Management

Site/operations managers or their delegates shall identify and assess all hazards related to powered mobile plant and vehicles at the workplace and the risk of people, facilities, plant and equipment coming into contact with those hazards. Appropriate controls to eliminate or minimize all identified risks shall be implemented.

A Traffic Management Plan especially in the area where transportation of flammable gases, refrigerants are taken place, shall be developed to ensure that pedestrians are physically separated (as far as is reasonably practicable) from all vehicles and powered mobile plant traversing or operating in any shared work space.

Management shall consult key stakeholders (such as powered mobile plant operators and other employees) when assessing and developing a Traffic Management Plan.

Site/operations managers or their delegates shall provide information and instruction to employees, contractors, customers and site visitors on the requirements of the Traffic Management Plan (e.g. through signage, workplace inductions and toolbox talks).

All drivers and operators shall hold a current license or certificate and are required to be deemed competent to operate the relevant mobile plant or vehicles.

Workplace inductions shall incorporate key traffic management requirements.

Contractors performing work for the plant shall be inducted into the work area or workplace in which they will be working.

Visitors who are at the workplace for the sole purpose of delivering or picking up goods shall remain on marked roadways, walkways or in the immediate proximity of their vehicles at all times when entering mobile plant areas.

Children are not permitted in operating areas of air condition production plants. Any children visiting workplaces are to be supervised at all times.

Employees shall supervise and, where applicable, escort all visitors to mobile plant work areas if they have not been officially inducted to the workplace.

Employees, contractors and visitors shall observe all posted or marked signs, including speed limits, traffic flow directions and mobile phone exclusion zones, at all times.

Employees, contractors and visitors shall wear high-visibility upper-torso garments at all times in areas where mobile plant operates, and shall remain on marked walkways (as appropriate).

An auditing and review process shall be implemented to ensure that the Traffic Management Plan is current and to review the effectiveness of controls.

Management shall provide adequate technical and financial resources to implement and maintain agreed controls.

7.11 Workplace Environmental Management

Refer to:

Ministerial Regulation on the Prescribing of Criteria and Method of Conducting Health Checkup of Employees and Forwarding the results of health checkup to labor inspector B.E. 2547(A.D.2004) by Ministry of Labor and Welfare.

Ministerial Regulation on the Prescribing of Standard for Administration and Management of Occupational Safety, Health and Environment in Relation to Heat, Light and Noise B.E. 2549 (2006) by Minister of Labor

Every workplace shall enforce in order to meet their legal responsibility of providing a safe working environment. The following minimum mandatory requirements shall be implemented to ensure workplace compliance in relation to health surveillance:

Prospective employees and relevant contractors shall participate in a pre-placement medical assessment using the Pre- and Post-Placement Health Assessment

7.12 Personal Protective Equipment

The Site/Operation Manager or Front Line Supervisor shall ensure that a PPE risk assessment is completed for all Personal Protective Equipment requirements.

Appropriate signage which indicates the identified hazard and the required PPE shall be displayed wherever PPE is required to be worn.

All employees (including management), contractors, and visitors shall wear PPE when required to do so. If contractors fail to wear the appropriate PPE their contract shall be reviewed and may be cancelled without further payment.

Employees shall be consulted in the PPE selection process.

All employees shall receive comprehensive training in the use of PPE relevant to their duties. When professional assessment deems it necessary, PPE shall be individually made and fitted to ensure maximum effectiveness.

All PPE shall be stored and maintained according to the manufacturer's specifications. Employees are expected to actively assist management in maintaining PPE.

PPE audits shall be conducted regularly to ensure that the equipment offers maximum protection, and daily pre-use visual checks by the user shall occur to ensure the equipment is fit for use.

If for any reason an employee cannot be equipped with the appropriate PPE (e.g. the employee has a medical condition that prevents them from wearing the item), they will not be permitted to enter the hazardous area.

7.13 Training and Certification Management

Refer to: Occupational Safety, Health and Environment Act B.E. 2554 by Ministry of Labor and Welfare, section 16.

To ensure the level of knowledge, skills and competencies of employees who involve in storage, handling, charging, evacuating, and leak testing refrigerants, flammable gases, non-flammable compressed, liquefied gases, and hazardous materials in the production process of air conditioner.

Occupational, Health and Safety (OHS) training objectives and targets and performance indicators shall be identified, monitored and evaluated for effectiveness. Resources shall be provided to ensure the effective implementation of the OHS training program. OHS training shall be provided to ensure persons understand and are aware of their OHS responsibilities. OHS Training shall ensure individuals required to perform work or operate equipment hold appropriate current licenses or certificates of competency in accordance with OHS legislative requirements Managers or supervisors shall ensure all persons under their authority can demonstrate competency to perform the work or operate equipment and not be solely reliant on the person's license or certificate as proven competence. OHS skills and knowledge requirements relating to contractors and the supply of labor shall be documented and communicated to the supplier, before the purchasing/tendering process commences. Employees, other workers, visitors and contractors shall be inducted to the workplace. The level of induction will be relevant to the level of risk and supervision. A Training Needs Analysis shall be completed for each site or area. Training plans and programs shall be developed based on the skills of the persons and the outcomes of the training needs analysis. Differences in learning, language, literacy and numeracy skills of trainees shall be taken into account in training programs. OHS training shall include clearly stated learning outcomes and where relevant, include a competency or assessment activity related to the learning outcomes.

7.14 Emergency Response

Refer to:

Notification of the Ministry of Industrial Subject: Factory Fire Prevention and Control B.E. 2552.

Ministerial Regulation of Occupation Safety, Health and Environmental Standards for Fire Prevention and Control B.E. 2555.

Notification of the Ministry of Welfare and Labor Protection, Subject: Portable Fire Extinguisher Standards B.E. 2556.

Notification of the Ministry of Industry, Subject: Industrial Standards of Lamp for emergency exit signs of indoor building.

Notification of the Ministry of Welfare and Labor Protection, Subject: Basic Fire Fighting Practice and Fire Evacuation Exercise Requirement B.E. 2556.

Notification of the Ministry of Industry, Subject: Hazardous Substances Land Transportation B.E. 2546.

Notification of the Hazardous Substances Land and Transportation B.E. 2546.

To comply with the above laws and regulation;

- The site/operations manager or their delegate shall identify Potential emergency situations on, or in the vicinity of, the workplace and develop a Site Emergency Response Plan. Emergency procedures are documented and regularly reviewed.

- Each workplace shall have an established communications system that allows effective communication.
- Each workplace shall establish immediately available internal and external emergency contact details.
- The site/operations manager or their delegate shall allocate overall responsibility for the control of emergency situations to specific individuals, and shall communicate this information to all employees by completing and displaying the Emergency Response Contacts.
- Competent personnel shall assess the suitability, location and accessibility of emergency equipment.
- Emergency and fire-protection equipment, exit signs and alarm systems shall be regularly inspected, tested and maintained.
- Where required, dangerous goods and hazardous substances manifests or registers shall be established and shall comply with legislative requirements.
- First aid requirements shall be assessed, and the first aid system shall be appropriate to the operational risks.
- Emergency exercises, drills and review of effectiveness shall be conducted and details documented at least once a year.

7.15 Waste Management

In the production of air conditioner few types of solid waste are generated such as empty chemical drums, oil drums, waste paint sludge from paint booth, powder coating waste from dust collector, metal dust from metal workshop, etc. These shall be collected, contained, transferred, and disposed properly.

Hazardous/special waste generator locations must be especially careful to comply with regulatory Requirements: Government authorities usually must be notified to obtain an identification number or License: A written waste management and/or contingency plan for emergencies may be required. Moreover, regulatory requirements includes the followings:

- Waste storage
- labeling
- Inspections
- manifesting (Duty of Care)
- Record-keeping; and
- reporting requirements.

Documented training of employees handling or exposed to hazardous waste is also often required by Legislation.

Note: all equipment that is removed and replaced with the Ex-Proof for HFC-32 shall be disassembled, and disposed by the approved waste disposers.

8. Estimated Budget for Mitigation Measures

| Item | Description | Estimated unit cost (THB) |
|------|--|---------------------------|
| 1 | Redesign of work area to keep distance where HFC-32 is used and the area where ignition sources from the adjacent process. | 500,000 |
| 2 | Redesign of storage facility. See more detail on Item 7.2 Safety criteria for the construction of storage facility for HFC-32. | 450,000 |
| 3 | Installation of the Ex-Proof electrical equipment in the storage area and production line around refrigerant charging and vacuum and also the electrical used in performance test labs. | 75,000 |
| 4 | Ex-proof type of transfer pumps, vacuum pumps, charging machines, and piping are required. | 750,000 |
| 5 | Ventilation system – general ventilation and local ventilation at the charging station. | 300,000 |
| 6 | Gas detection and alarm system. See more detail on section 7.2 Safety criteria for the construction of storage facility for HFC-32 | 200,000 |
| 7 | Redesign or improvement on fire protection is required. Especially when large volume of container like 1 ton is to be stored, adequate fire water for cooling gas container to prevent Boiling Liquid Expanding Vapor Explosion (BLEVE). | 360,000 |
| 8 | Reviewing of fire emergency response plan shall be done to ensure that the local fire department is familiar with fire at the compressed gas cylinders. Fire water cooling system shall be redesigned to cover HFC-32 storage area. | 250,000 |
| 9 | Training of the workers who handling HFC-32 to be aware of its physical properties, flammability, immediate health hazards and personal protective equipment to be used. | 150,000 |

9. Time Schedule for Implementation of the Environmental Management Plan (EMP)

| Actions | Schedule | Responsible party/person | Monitoring/ Measurement |
|--|--------------------------------------|---------------------------|--|
| Develop action plans against mitigation measures | January 2014 | Participating enterprises | Approved action plan under sub-project |
| Implement mitigation action plans, re-layout, install new equipment. | After signing of sub-grant agreement | Participating enterprises | Approved action plan under sub-project |
| Re-arrange and construct storage area for HFC-32 | After signing of sub-grant agreement | Participating enterprises | Approved action plan under sub-project |
| Install gas detection and alarm at refrigerant charging, vacuum, leak testing, test labs, and warehouse. | After signing of sub-grant agreement | Participating enterprises | Approved action plan under sub-project |
| Install fire protection system at HFC -32 storage area. | After signing of sub-grant agreement | Participating enterprises | Approved action plan under sub-project |
| Provide training/ SOPs training and coaching | After signing of sub-grant agreement | Participating enterprises | Training records |

10. Environmental Monitoring Plan

| Indicators | Schedule | Responsible party/person |
|---|----------------------------------|-------------------------------|
| Accident statistics and reporting | Once a year | Safety officer of enterprises |
| Waste disposal record (from the production line) | Once a year | Safety officer of enterprises |
| Waste disposal record (from conversion process) | Once | Safety officer of enterprises |
| Maintenance of equipment in a good condition i.e. preventive maintenance and/or calibration | Once a year | Manager of assembly line |
| Pre-commissioning audit | After installation of equipment | DIW |
| Post-commissioning audit | After commissioning of equipment | DIW |

References

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2. Environmental, Health, and Safety (EHS) Guidelines GENERAL EHS GUIDELINES: INTRODUCTION, IFC World Bank
3. Pollution Prevention and Abatement Handbook 1998 Toward Cleaner Production, World Bank
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5. WMO (World Meteorological Organization), Scientific Assessment of Ozone Depletion: 2006, Global Ozone Research and Monitoring Project—Report No. 50, 572 pp., Geneva, Switzerland, 2007.
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8. BS 5345 Pt 1 & 3 – The Code of Practice for Selection, Installation and Maintenance of Electrical Apparatus for use in Potentially Explosive Atmospheres
9. Fire safety requirements for liquefied petroleum gas (LPG) cylinder installations, NFPA 54, 58
10. National Electrical Code, 2008 Edition, NFPA 70
11. Designation and Safety Classifications of Refrigerants, ANSI/ASHRAE Standard 34-1997, ANSI/ASHRAE Standard 34-2010, ANSI/ASHRAE Standard 34-2007
12. Asia Industrial Gases Association, SAFETY AUDIT GUIDELINES, AIGA 01405
13. ANSI Z49.1 2005 Safety in welding cutting and allied process

ANNEX 1 Hazard Identification and Risk Assessment Guideline

The purpose of this guideline is to provide a the air conditioner manufacturing plant standard for Occupational Health Safety and Environmental-OSHE risk management to ensure that health and safety risks associated with the production processes, activities and tasks in air conditioner assembly, metal forming, powder coating , plastic parts injection, condenser units and evaporator units assembly, etc. are eliminated, or where that is not reasonably practicable, minimized by the application of the Hierarchy of Control.

The elimination or control of all reasonably foreseeable OHSE risks is the core component in the world-class organization's aspiration for a Zero Harm environment. The safety and welfare of people is our most important responsibility. Commitment from senior management to operate businesses in a manner which ensures that all of employees, contractors, visitors and the communities in which the facility operates are free from harm, injury and illness.

Legal and regulatory requirement implication:

Safety, Occupational Health and Working Environment Acts B.E.2554 and Regulations set out specific safety requirements for managing risks that every workplace shall enforce, in order to meet their legal responsibility of providing a safe working environment. Therefore, the minimum mandatory requirements shall be implemented to ensure all air conditioning manufacturing workplaces compliance in relation to OHS risk management.

Section 1 Clause 6 hold the employer responsible for provide and maintain safe and healthy working conditions to the employee. The law also requires consistent commitment from the employer to promote accident and injury prevention programs. The employee is obligated to cooperate with the employer in the safety, health and environmental activities implemented at the workplace.

To comply with this act, the employer are required to establish effective safety, health and working environmental management system which define roles and responsibility for top management, middle management, supervisor, and employee. The employer is obligated to provide training and competency to the employee to ensure they can perform the assigned tasks safely. The enforcement of this act is made by requiring the employer to submit reports which demonstrate effectiveness of assessing risk and implementation of control measures.

There are several ministerial regulations under this act that set clear expectation toward the employer to conduct effective risk management in the workplace.

Risk Management Process in due diligence:

The risk management process applied during the due diligence and to be mentioned in several subjects under this EMP is to identify all reasonably foreseeable sources of risk, areas of impact, events (including changes in circumstances) and their causes and their potential consequences. This includes the processes not only assembling parts of air conditioner and charging refrigerant into the units but includes:

- The physical work environment (e.g plant/workplace design, storage area of hazardous substances, refrigerants transportation to storage area and transferring it to the production lines, and controlling of potential ignition sources that can possibly ignite the escape flammable refrigerant, etc.).
- Knock on effects of particular consequences including cascading or cumulative effects.
- The type of work (e.g. metal forming, punching, stamping, powder coating, spot welding, copper coil brazing, parts assembly, maintenance of tools and equipment in the area where can be affected from and by the refrigerants).
- Working arrangements (e.g. staffing levels, working alone, shift duration and rosters), including the role and responsibilities of other persons working in the work place and public safety hazards.



Table A1-1 Term and Definition

| Term | Definition |
|-------------------------------------|---|
| consequence | The outcome of an event affecting objectives. |
| hazard | Any matter, thing, process or practice that may cause death, injury, illness or disease other loss or disadvantage. |
| Hierarchy of Control | The system that is applied in descending order to control hazards. |
| likelihood | The chance of something happening. |
| Personal Protective Equipment (PPE) | Clothing and equipment which is worn to reduce the risks from OHS hazards. PPE may include a high-visibility vest, protective eyewear, steel-capped boots, protective clothing, gloves, hats etc. |
| residual risk | The remaining level of risk after risk controls have been implemented. |
| Reasonably practicable | <p>That which is, or was at a particular time, reasonably able to be done in relation to ensuring health and safety, taking into account and weighing up all relevant matters including:</p> <ul style="list-style-type: none"> the likelihood of the hazard or the risk concerned occurring; and the degree of harm that might result from the hazard or the risk; and what the risk assessor concerned knows, or ought reasonably to know, about: <ul style="list-style-type: none"> (i) the hazard or the risk; and (ii) ways of eliminating or minimizing the risk; and the availability and suitability of ways to eliminate or minimize the risk; after assessing the extent of the risk and the available ways of eliminating or minimizing the risk, the cost associated with available ways of eliminating or minimizing the risk, including whether the cost is grossly disproportionate to the risk. |
| risk | The combination of consequences and their likelihood |
| risk assessment | The identification, evaluation and estimation of the level of risk involved in a hazard, tasks, things or circumstances |
| risk management | The process by which hazards are identified, assessed, controlled and reviewed. |

Risk Matrix

The following criteria are to be used for describing hazards identified on the due diligence report.

Table A1-2 Consequence rating

| Consequence rating | | |
|--------------------|-------------|--|
| Value | Description | Impact / Examples |
| 1 | Minor | First aid treatment, Medium financial loss On-site environmental release immediately contained |
| 2 | Moderate | Medical treatment required, or Lost Time Injuries (LTIs), On-site environmental release contained with outside assistance, requiring remediation work , High financial loss |
| 3 | Major | Permanent disability or extensive injuries resulting in greater than seven days lost time, fatality, Business interruption for an extended period , Environmental damage that results in prosecution or major remediation work , Major financial loss/conviction |

Table A1-3 Likelihood rating

| Likelihood rating | | |
|-------------------|-------------|--|
| Value | Description | Impact / Examples |
| 3 | Likely | The event will probably occur in most circumstances. |
| 2 | Possible | The event might occur at some time. |
| 1 | Unlikely | The event could occur at some time. |

Table A1-4 Risk Matrix

| Likelihood/Consequence | Consequence | | |
|------------------------|-------------|--------------|------------|
| Likelihood | Minor (1) | Moderate (2) | Major(3) |
| Likely (3) | Medium (3) | High (6) | High (9) |
| Possible (2) | Low (2) | Medium (4) | High(6) |
| Unlikely (1) | Low (1) | Low (2) | Medium (3) |

Table A1-5 Hierarchy of controls

| Hierarchy of controls | |
|-------------------------------------|---|
| Controls | Explanation/ examples |
| Elimination | Is there a need to use the plant, process or substance that created the risk (e.g. using a explosion proof tool to eliminate the ignition source in the area where flammable –air mixture can reach LFL) |
| Substitution | Can the hazardous item be substituted with another item that has less risk ? |
| Engineering | Can the risk be minimized by isolating, enclosing or redesigning the plant, substance or process (e.g. machine guards, mechanical lifting aids, exhaust ventilation, relocation, trolleys or workstation design)? |
| Administrative | Administrative efforts to ensure the likelihood of occurrence can be reduced by variety ways. For example E.g. job rotation, SOP, training and signs. |
| Personal Protective Equipment (PPE) | The least-desirable method which shall only be used in combination with other controls or if other controls are not suitable. Employees issued with PPE shall have it fitted correctly and be trained in its use and maintenance. |

ANNEX 2 Typical Air Conditioner Production Risk Profile

The purpose of this document is to provide a the air conditioner manufacturing overview of Occupational Health Safety and Environmental risk associated with the production processes, activities and tasks in air conditioner assembly, metal forming, powder coating , plastic parts injection, condenser units and evaporator units assembly, etc.



General guideline and best safe practices to elimination or control of all reasonably foreseeable risks are to be described. To comply with proposed control measures are the responsibility of the management of the workplace.

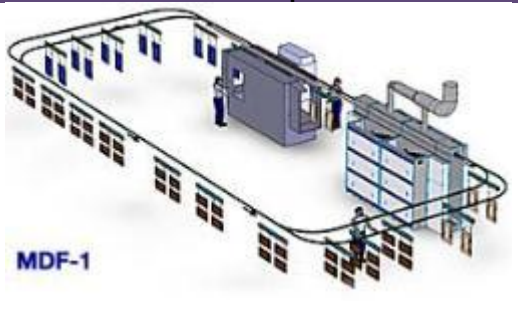

Air Conditioner Manufacturing Processes;

This assessment is based on the observation made during site visit and the document provided from the air conditioner factories who are participating in the program to phase out HCFC-22to HFC-32. Many of them are a large scale where most of the parts required for AC assembly lines are produced in-house. Typically, there are three major components in the AC production lines;




1. Metal parts produced from metal forming machines. The process starts from custom cut size -metal sheets to be cut, folded, punched, weld, to form the casing of the AC unit. In the process of making metal parts, powder coating spray and heat treatment is commonly observed at most of the AC factories. Some of them has very well design of the working area where all metal parts production line and dry powder coating process are located separately from the area where flammable gases and solvent are used.
2. Plastic injection and molding to produce plastic case, frame, front panel and accessories. This includes the process of spraying liquid adhesive and installation of noise acoustic material onto the panel of the in-door units.
3. Coil making is the process of making copper, aluminum tubes, bending, expanding, brazing, and pressure testing.
4. AC Assembly is a process where all components to be assembled. Air compressor which is the most important component of the AC system is to be installed. There is a lot of brazing work during this process. The electronic components are also installed onto the units. Functional testing process is taking place during the assembly steps.
5. Refrigerant vacuum, and charging is a process take place
6. Leak Testing is a critical step to ensure there is no leak of the charged refrigerant.
7. Performance Testing is the quality control test to ensure all required quality are met the local industrial standards.
8. Packing and shipment to the warehouse

| Process/ activity | Description | Potential Hazards and Risk | Suggested Control measures |
|--|--|---|--|
| <p>Metal Parts production Common sheet metal forming and shaping machines:</p> <p>Mechanical Power Presses Power Press Brakes Powered and Non-Powered Conveyors Printing Presses Roll-Forming and Roll-</p> |  <p>Machine operator manually feed metal piece into the power press machine. Risk of hand and finger injury.</p>  |  <p>Reciprocating Motion is back-and-forth or up-and-down motion that may strike or entrap an employee between a moving part and a fixed object. Understanding the mechanical components of machinery, the hazardous mechanical motion that occurs at or near these components and specific employee activities performed in conjunction with machinery operation will help employees avoid injury.</p> |  <p>Good example: Fix guarding and limit switch that will stop the machine once the fixed guard has been removed.</p> |
| <p>Bending Machines Shearing Machine Band Saws Drill Presses Milling Machines Grinding Machines Slitters Roll Former CNC</p> | <p>Two hand buttons have been defeated. Risk of hand injury</p> | <p>Employees operating and caring for machinery perform various activities that present potential amputation hazards.</p> <p>Machine setup/threading/preparation, Machine inspection, Normal production operations, Clearing jams, Machine adjustments, Cleaning of machine, Lubricating of machine parts,</p> | <p>Effective implementation of Machine Safe Guarding Implement Lock Out Tag Out Procedure Training and Certification Preventive Maintenance Programs Housekeeping Material handling equipment Manual Handling PPE</p> |

| Process/ activity | Description | Potential Hazards and Risk | Suggested Control measures |
|---|--|--|---|
| Metal parts Arc welding Spot welding |  |  | Separate lay-out Good housekeeping Keep clear from combustible and flammable material Safety sign Fire extinguisher |
| Metal pre-treatment Powder Coating | Part preparation or the pre-treatment The powder application Curing | The pre-treatment process both cleans and improves bonding of the powder to the metal. Recent additional processes have been developed that avoid the use of chromates, as these can be toxic to the environment | Solid Waste management Waste water treatment Hazardous material spill and leakage control procedure Housekeeping, Dust control PPE Keep the workplace clean Aware of storage and handling chemical hazard MSDS Emergency eye wash and shower Training and certification |
| Chemical pre-treatments involve the use of phosphates or chromates in submersion. These often occur in multiple stages and consist of degreasing, etching, de-smutting, various rinses and the final phosphating or chromating of the substrate. |  | | |

| Process/ activity | Description | Potential Hazards and Risk | Suggested Control measures |
|---|---|--|---|
| <p>Powder spray takes place in a confined spray booth.</p> <p>The metal work pieces are hung from the overhead conveyor.</p> |  | <p>When a thermoset powder is exposed to elevated temperature, it begins to melt, flows out, and then chemically reacts to form a higher molecular weight polymer in a network-like structure. This cure process, called crosslinking, requires a certain temperature for a certain length of time in order to reach full cure and establish the full film properties for which the material was designed. Normally the powders cure at 200°C (390°F) for 10 minutes</p> | <p>Pre-start up check list Follow standard installation code for LPG piping and manifolds Emergency response plan that cover LPG leak</p> |
| <p>Plastic Injection</p> <p>This process associated with plastic injection and molding machines. Storage and handling plastic raw material.</p> <p>Operating machine and make sure no plastic is jammed inside the mold and catch on fire.</p> |  | <p>Risk of LPG gas leak, fire and explosion of the dry oven during shut down and start up.</p> <p>Fire hazards Exposure to hot surfaces Hand and finger injury when clearing jam</p> | <p>Pre-start up checklist PPE Housekeeping</p> |

| Process/ activity | Description | Potential Hazards and Risk | Suggested Control measures |
|---|--|--|---|
| <p>Spraying solvent based adhesive material onto the plastic front panel and install acoustic sheet on it.</p> |  |  | <p>Spray booth with LEV Eliminate ignition sources Flammable liquid handling and storage Housekeeping PPE</p> |
| | <p>Adhesive material is solvent based which contain toluene, or other type of solvent.</p> | <p>Spraying process generate emission of flammable and toxic vapor Health hazards Fire and explosion hazards</p> | |

| Process/ activity | Description | Potential Hazards and Risk | Suggested Control measures |
|---|---|---|---|
| <p>Brazing and welding</p> <p>Is a common activities observed in the process of making coils for condensers and evaporator. Brazing also used in the process of assembly air compressor.</p> |  |  | <p>Control of LPG storage, installation of LPG header, piping, regulator, valves, hoses, welding torch, and the use of flash back arrestor</p> <p>Control of Oxygen cylinder storage, handling, awareness of oxygen incompatibility hazards, valves, and regulator control Flash back arrestor</p> <p>Pre-start checklist Housekeeping Fire emergency plan Fire extinguishers</p> |
| |  | <p>Fire and explosion hazards associated with LPG and Oxygen mixture</p> <p>Health Hazard from expose to welding radiation, metal fume and the exposure to welding flux.</p> <p>Hand and finger injury from heat burn</p> | <p>Training and competency management</p> |

| Process/ activity | Description | Potential Hazards and Risk | Suggested Control measures |
|----------------------|---|--|--|
| Assembly line |  | <p>Manual Handling Electrical hazards Fire hazards Portable powered tools Slip and tripping Repetitive motions and ergonomics</p> | |
| Refrigerant charging |  |  | <p>Storage and handling procedure Area classification Detection and alarm system LEV Pre-start up checklist Charging equipment inspection and maintenance Elimination ignition sources Leak testing procedure Fire suppression system Housekeeping Piping and manifold design criteria</p> |

| Process/ activity | Description | Potential Hazards and Risk | Suggested Control measures |
|-------------------|-------------|----------------------------|----------------------------|
|-------------------|-------------|----------------------------|----------------------------|



See detail discussion about HFC-32 Annex 3

Finish good handling and storage



Finish goods when charged with the refrigerant are packed inside the package that protects them from damage due to mishandling

Follow safe warehouse management practices
 Inspect rack and storage area
 Keep the walkways, forklift ways clear
 Fire hazard inspection
 Leak test
 Housekeeping

ANNEX 3 Area Classifications for the Design of Production Line Where HFC-32 is Used.

Objective:

In a situation in which there may be an explosive (flammable) atmosphere, the following steps should be taken:

- a) Eliminate the likelihood of an explosive gas atmosphere occurring around the source of ignition, or
- b) Eliminate the source of ignition.

Where this is not possible, protective measures, process equipment, systems and procedures should be selected and prepared so the likelihood of the coincidence of a) and b) is so small as to be acceptable.

Thai Legal implication:

According to Hazardous Substances Act B.E.2535, it is compulsory for the authority to prepare the standards for controlling (Revision 2 B.E. 2544, and Revision 3 B.E.2551);

- Ingredients
- Characteristics
- Purity
- Container and package inspection and testing requirement
- Labeling
- Manufacturing
- Importing
- Exporting
- Transportation
- Storage
- Container disposal requirement

According to Hazardous Substances Act B.E.2535, HCFCs and HFCs are classified as hazardous substance type 3 for which production, import, export or having in possession must have a license. To obtain a license, full compliance to relevant regulatory requirements is mandatory.

DIW Notification on Storage of Chemical and Hazardous Substances B.E. 2550 establishes a complete set of directives that can be used as a reference when air conditioner manufacturer are planning for new storage area of HFC-32 or making improvement of the existing storage facility.

In summary the Chemical and Hazardous Material Storage Manual B.E. 2550 covers;

- Specific criteria for fire wall
- Type and characteristic of the floor
- Means of egress and emergency exits
- Type and characteristic of roofing material
- Ventilation requirement
- Electrical, emergency light, and electrical appliances requirement
- Lightning protection
- Detection and alarm systems
- Fire protection

Ministerial order on Fire prevention and control B.E. 2552 is applicable to all air conditioner manufacturers. Since most of the air conditioner plants are registered under the type 70, or 71 which are classified by this regulation as "medium fire risk factory". Fire detection system, fire alarm, and fire suppression system requirements are specified.

Summary

HCFC-22 Safety Data

Chlorodifluoromethane CAS NO. 75-45-6

Physical property:

Colorless, volatile liquid with ethereal and faint sweetish odor. Non-flammable material. Overexposure may cause dizziness and loss of concentration. At higher levels, CNS depression and cardiac arrhythmia may result from exposure. Vapors displace air and can cause asphyxiation in confined spaces. At higher temperatures, (>250°C), decomposition products may include Hydrochloric Acid (HCl), Hydrofluoric Acid (HF) and carbonyl halides.

Transportation:



Figure 1 Color Code for Refrigerant container

Health Hazards:

SKIN: Irritation would result from a defatting action on tissue. Liquid contact could cause frostbite.

EYES: Liquid contact can cause severe irritation and frostbite. Mist may irritate.

INHALATION: R-22 is low in acute toxicity in animals. When oxygen levels in air are reduced to 12-14% by displacement, symptoms of asphyxiation, loss of coordination, increased pulse rate and deeper respiration will occur. At high levels, cardiac arrhythmia may occur.

INGESTION: Ingestion is unlikely because of the low boiling point of the material. Should it occur, discomfort in the gastrointestinal tract from rapid evaporation of the material and consequent evolution of gas would result. Some effects of inhalation and skin exposure would be expected.

DELAYED EFFECTS: None Known

Flammability

FLASH POINT: Gas, not applicable per DOT regulations

FLASH POINT METHOD: Not applicable

AUTOIGNITION TEMPERATURE: Unknown

UPPER FLAME LIMIT (volume % in air): None*

LOWER FLAME LIMIT (volume % in air): None*

*Based on ASHRAE Standard 34 with match ignition

FLAME PROPAGATION RATE (solids): Not applicable

OSHA FLAMMABILITY CLASS: Not applicable

R-22 is not flammable at ambient temperatures and atmospheric pressure. However, this material will become combustible when mixed with air under pressure and exposed to strong ignition sources. Contact with certain reactive metals may result in formation of explosive or exothermic reactions under specific conditions (e.g. very high temperatures and/or appropriate pressures). R-22 should not be mixed with air above atmospheric pressure for leak testing or any other purpose.

Store in a cool, well-ventilated area of low fire risk and out of direct sunlight. Protect cylinder and its fittings from physical damage. Storage in subsurface locations should be avoided. Close valve tightly after use and when empty.

US DOT PROPER SHIPPING NAME: Chlorodifluoromethane

US DOT HAZARD CLASS: 2.2 – Non-Flammable Gas

US DOT PACKING GROUP: Not applicable

US DOT ID NUMBER: UN1018



Summary

Reference from : MSDS No. 001054 Dated 4/27/2010 from

AIRGAS INC., on behalf of its subsidiaries
259 North Radnor-Chester Road
Suite 100
Radnor, PA 19087-5283
1-610-687-5253

HFC-32 Safety Data

Difluoromethane

Methylene fluoride; Carbon fluoride hydride (CF₂H₂); Difluoromethane; Freon 32;

Genetron 32; Methylene difluoride; CH₂F₂; R 32

CAS NO. 75-45-6

Physical property: Gas. [Liquefied gas]

WARNING!

- EXTREMELY FLAMMABLE GAS.
- MAY CAUSE FLASH FIRE.
- MAY BE HARMFUL IF SWALLOWED.
- CAN CAUSE TARGET ORGAN DAMAGE.
- Keep away from heat, sparks and flame.
- Use only with adequate ventilation. Wash thoroughly after handling. Keep container closed.

Flammability of the product: Flammable

Auto-ignition temperature: 647.13°C (1196.8°F)

Flammable limits: Lower =14% Upper = 31%

Heavier than air 3.82

US DOT PROPER SHIPPING NAME: Difluoromethane

US DOT HAZARD CLASS: 2.1 – Flammable Gas

US DOT PACKING GROUP: Not applicable

US DOT ID NUMBER: UN 3252



ASHRAE STANDARD ANSI/ASHRAE STANDARD 34-2010

Designation and Safety Classification of Refrigerant

Table A3-1 Safety Classification of Refrigerants

| | Safety group | |
|----------------------|----------------|-----------------|
| Higher Flammability | A3 | B3 |
| Lower Flammability | A2 | B2 |
| | A2L* | B2L* |
| No flame Propagation | A1 | B1 |
| | Lower Toxicity | Higher Toxicity |

HCFC-22 has been classified under Safety Group A1 based on the test result that indicates two characteristic; no flame propagation and lower toxicity.

HFC-32 has been classified under Safety Group A2L because it is lower toxicity refrigerant and lower flammability refrigerant with a maximum burning velocity of less than or equal 10 cm. per second.

Table A3-2 Refrigerant Safety Group classification comparison

| Refrigerant number | Chemical name | Chemical formula | Molecular mass | Boiling point °C | Boiling point °F | Safety Group | Highly or Toxic under code classification |
|--------------------|--------------------------------------|------------------------------------|----------------|------------------|------------------|--------------|---|
| 22 | Dichlorodifluoromethane | CHClF ₂ | 86.5 | -41 | -41 | A1 | Neither |
| 32 | Difluoromethane (methylene fluoride) | CH ₂ F ₂ | 52.0 | -52 | -62 | A2L | Neither |
| 141b | 1,1-dichloro-fluoroethane | CH ₃ CCl ₂ F | 117.0 | 32 | 90 | | Neither |

Remark: American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)

According to ASHRAE INDUSTRIAL ADVERTISING POLICY ON STANDARDS,

ASHRAE Standards and Guidelines are established to assist industry and the public by offering a uniform method of testing for rating purposes, by suggesting safe practices in designing and installing equipment, by providing proper definitions of this equipment, and by providing other information that may serve to guide the industry. HFC-32 is classified under safety group A2L (Mildly Flammable Refrigerant).

The risk associated with storage and handling large quantity of HFC-32 in air conditioner factory when compared with the risk of HFC-32 in a single unit of air conditioner is different.

Discussion about Fire and Explosion risk in the air conditioner assembly line where HFC-32 is used.

It is possible a that gases, and escape during the production, processing, transportation and storage of flammable materials in air conditioner industries During many processes also flammable refrigerant can leak out due to mishandling, hose rupture, or leakage of equipment. HFC-32 has the range of flammability between 14%-31%. In the situation where flammable mixture is formed, the only chance to prevent fire and explosion is to eliminate ignition sources. The area around charging and vacuum station shall be clear from naked flame from brazing/welding, free from electric arc and spark from electrical appliances, static charge from poor grounding and bonding. One essential question is, on what legal requirement or international standard that the area classification is defined for the proposed HFC-32 area.

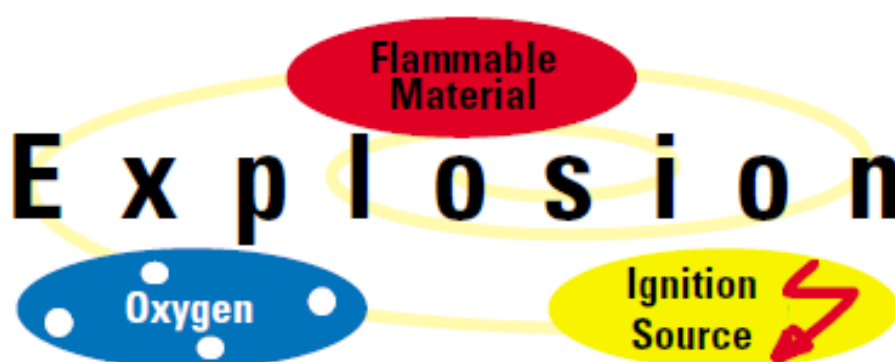


Figure 1 Component of Fire and explosion

Certain characteristic properties of these materials are required for safety considerations. The flash point of a flammable liquid is the minimum temperature at which a liquid gives off vapor in sufficient concentration to form an ignitable mixture with air near the surface of the liquid (at normal air pressure). If the flash point of a flammable liquid is far above the maximum temperatures which arise, an explosive atmosphere may not be formed. The flash point of a mixture of various liquids may be lower than that of the individual components.

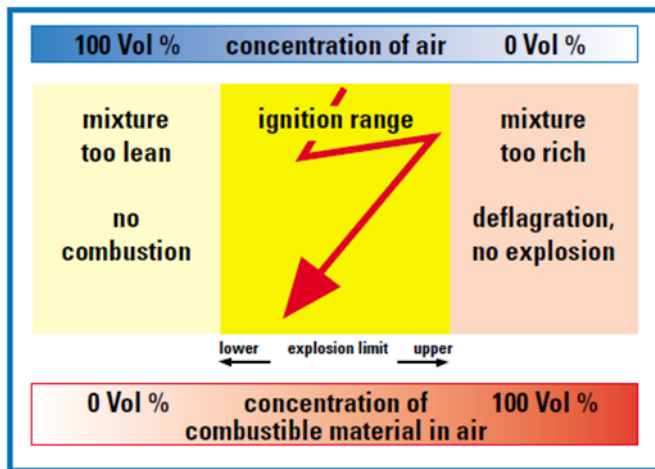
HFC-32 comes in the form of liquefied gas. When it leak it will instantly become gas at the room temperature of air conditioner production area.

Table A3-3 Danger classification by flash point

| Danger Class | Flash point |
|--------------|-----------------------------------|
| AI | < 21 °C |
| AII | 21 to 55 °C |
| AIII | >55 to 100 °C |
| B | <21 °C, soluble in water at 15 °C |

As mentioned above the flammability of HFC-32 and air mixture is between 14%-31%. The likelihood of having flammable mixture in the air conditioner production line under normal circumstances is unlikely. However, this is depending on how well the plant equipment is maintained. How proper is the work processes associated with HFC-32 handling, connecting, charging are performed. To reach the lower flammable limit at 14% is seem to be likely if the production line is not in comply with minimum standard practices where incident that lead to uncontrolled release of HFC-32 can occur.

For an explosive atmosphere to form, the flammable material must be present in a certain concentration. If the concentration is too low (lean mixture) or too high (rich mixture), no explosion occurs, rather there is just a slow combustion reaction or none at all.



Most likely ignition sources that will ignite the flammable mixture in the area near HFC-32 charging; hot surfaces.

- electrical arcs and sparks
- electrostatic discharge
- atmospheric discharge (lightning)
- mechanical friction or impact sparks
- open flames
-

Primary explosion protection refers to all precautions which prevent a dangerous, explosive atmosphere from being created. This can be achieved by:

- avoiding flammable substances (replacement technologies)
- deactivation (addition of nitrogen, carbon dioxide etc.)
- limitation of the concentration
- natural or artificial ventilation

The principle of integrated explosion protection requires explosion protection measures to be taken in a certain sequence. If the danger of explosions cannot be completely or only partly avoided by primary explosion protection measures, then measures must be taken which prevent the ignition of an explosive atmosphere. The hazardous locations are therefore divided into zones, according to the probability of an explosive atmosphere being created. In the USA and other countries, hazardous locations are classified into Classes and Divisions. For areas classified in this way, requirements must be met concerning the apparatus which are approved to be used in these locations. In addition it is stipulated how to prove that these minimum requirements have been met.

Table A3-4 Overview of the zone and allocation of equipment (Equipment category in according to 94/9EC)

| Gases, Vapors, Mists | Dust | Definition (94/9/EC) explosive atmosphere is present: |
|-----------------------------|------------------------|--|
| Zone0 -> Category 1 G | Zone20 -> Category 1 D | Continuous or long term or frequently |
| Zone1 -> Category 2 G | Zone21 -> Category 2 D | Occasionally |
| Zone2 -> Category 3 G | Zone22 -> Category 3 D | Infrequently or short period |
| G= Gas, D= Dust | | |

Thailand has no specific laws and regulatory requirement regarding hazardous area classification which guiding the decision of selecting the right level of protection of electrical appliances but rather refer to recognized international standards such as UL, IEC, FM.

Table A3-5 Zone classification according to IEC, NEC 500 and NEC 505

| Standards | Flammable gas present at all times | Flammable gas present at normal condition | Flammable gas present at abnormal condition |
|-----------|------------------------------------|---|---|
| IEC | Zone 0 | Zone 1 | Zone 2 |
| NEC 500 | Class 1 Division 1 | | Class 1 Division 2 |
| NEC 505 | Zone 0 | Zone 1 | Zone 2 |

Hazardous locations are classified into zones to facilitate the selection of appropriate electrical apparatus as well as the design of suitable electrical installations. Information and specifications for the classification into zones are included in IEC 60 079-10 and in national standards. Furthermore, a European Directive (ATEX 118a), which deals with the installation and operation of electrical systems in hazardous locations and governs the zone classification within the EC, is currently being prepared. The following table contains an overview of the zones and allocation of equipment (equipment category according to 94/9/EC) for the relevant zones. It would be uneconomical and sometimes not even possible to design all explosion protected electrical apparatus in such way that it always meets the maximum safety requirements, regardless of the use in each case. For this reason, the equipment is classified into groups and temperature classes in accordance with the properties of the explosive atmosphere for which it is intended. First of all a differentiation is made between two groups of equipment: Group I: Electrical apparatus for mining; Group II: Electrical apparatus for all remaining potentially explosive atmospheres. In air conditioner manufacturing production lines;

Location in which ignitable concentrations of HFC gases, produced can exist under normal operating conditions, or in which ignitable concentrations of such flammable HFC-32 gases above their flash points may exist frequently because of repair or maintenance operations or because of leakage, or in which breakdown or faulty operation of equipment or processes might release ignitable concentrations of HFC-32 cause simultaneous failure of electrical equipment in such a way as to directly cause the electrical equipment to become a source of ignition.

The area where fall under Zone 0 or Class I, Division 1. A Class I, Division 1 location is at refrigerant storage area, the dosing/ metering pump, area near the nozzles of charging hoses, piping, charging machine, and inside the refrigerant charging room are classified Zone 0. In these locations HFC-32 is to be transferred from its container into dosing/metering pump. In the situation where solvent based glue sparing, or solvent based paint is spraying, there is flammable vapor generated continuously, this location also classified as Zone 0, or class 1 division 1 as well.

Zone 1 or class 1 division 2 area: The refrigerant charging room in which HFC-32, or LPG which are flammable gases present in the air under normal operating conditions in quantities sufficient to

produce explosive or ignitable mixtures, or mishandling of gases cylinders during transportation due to mechanical failure or abnormal operation of machinery.

There is very rare situation in AC manufacturing production line that is fall into Zone 2 classification. The question of possible risks of explosion must be addressed at the early stages of planning a new facility. Determination of the radius of zone 0, and zone 1 required detail study and physical examination of the plant equipment, flow rate, distances between each elements by the experts. When classifying potentially explosive areas, the influence of natural or artificial ventilation must be considered in addition to the levels of flammable materials being released.

Furthermore, the classification figures relating to explosion technology must be determined for the flammable materials being used Only then a decision can be reached on the division of potentially explosive areas into Zones and the selection of suitable apparatus.

Protection Techniques

Reference NFPA 70 Section 500.7(A) ARTICLE 500— HAZARDOUS (CLASSIFIED) LOCATIONS, CLASSES I, II, AND III, DIVISIONS 1 AND 2 shall be acceptable protection techniques for electrical and electronic equipment in hazardous (classified) locations that are marked;

a) Explosion proof Apparatus. This protection technique shall be selected for equipment in Zone 0 or Class I, Division 1 or 2 locations mentioned above.

(b) Intrinsic Safety. This protection technique shall be permitted for equipment in Class I, Division 1 or 2

(c) Combustible Gas Detection System. A combustible gas detection system shall be permitted as a means of protection in refrigerant charging area, and the storage rooms with restricted public access and where the conditions of maintenance and supervision under Permit To Work system to ensure that only qualified persons service the installation. Where such a system is installed, equipment specified in NFPA 70 500.7(K)(1), (K)(2), or (K)(3) shall be permitted. The type of detection equipment, its listing, installation location(s), alarm and shutdown criteria, and calibration frequency shall be documented when combustible gas detectors are used as a protection technique

ANNEX 4 Oxygen-Propane Brazing Safety Guideline

Oxy/fuel gas brazing is a common process in air conditioner manufacturing plant. Oxygen-Propane blow torch are used in copper tube- welding, heating, straightening. Small air conditioner plants use many Oxygen cylinders and Propane Gas cylinder in their operation. Large plant set propane and oxygen gas station outside the factory building. Gases supplied through manifold and piping system. Liquid Gas Flux connected to the gas manifold and fed into the welding/brazing tools. Oxy-Fuel welding is also being used in maintenance activity. Many people are injured each year by the incorrect or careless use of oxy/fuel gas equipment. Some people die. This guideline describes the hazards associated with portable or fixed oxy/fuel gas equipment and the precautions for avoiding injury and damage to property in air conditioner manufacturing process.

Legal obligation:

Employers are legally required to assess the risks in the workplace and take all reasonably practicable precautions to ensure the safety of workers and members of the public. Before using oxy/fuel gas equipment, a careful assessment of the risks should be carried out. This is particularly important if work is being carried out in unfamiliar surroundings.

Permit To Work System:

It recommended that the companies operate a written permit system for hot work. The permit details the work to be carried out, how and when it is to be done, and the precautions to be taken. A written permit system is likely to result in a higher standard of care and supervision. Oxy/fuel gas equipment should not be used unless it has been authorized by a suitably experienced manager or supervisor who has knowledge of the site, the work to be carried out, the risks involved and the precautions to be taken.

Training and Certification:

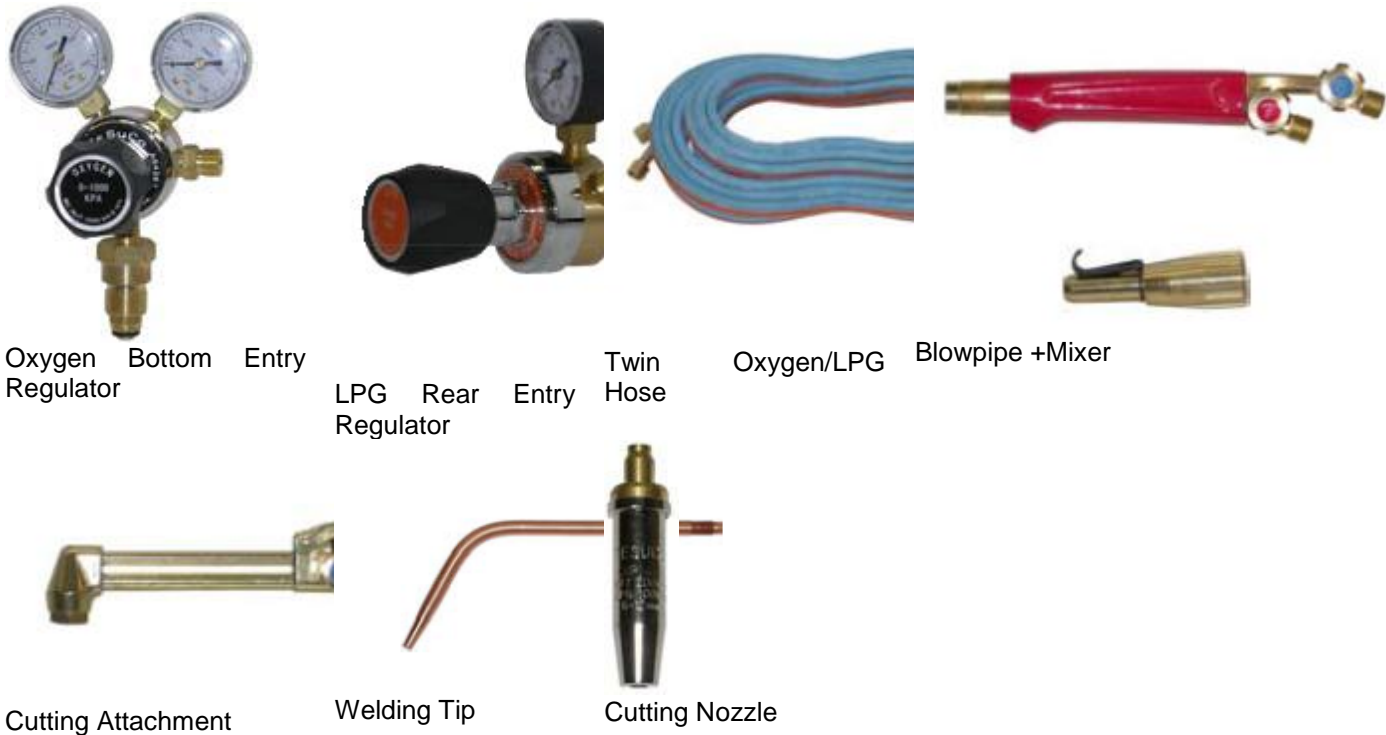
No one should use oxy/fuel gas equipment unless they have received adequate training in:

- the safe use of the equipment;
- the precautions to be taken;
- the use of fire extinguishers;
- the means of escape, raising the fire alarm and calling the fire brigade.

Oxy-Fuel Gas Welding Equipment:

All oxy/fuel gas processes operate in the same way. A fuel gas such as propane or acetylene is mixed with oxygen in a blowpipe (often called a 'torch') to produce a flame that is hot enough for the purpose. The main components of oxy/fuel gas equipment are:

- cylinders of oxygen and fuel gas (propane or acetylene);
- a means to shut off or isolate the gas supply, usually the cylinder valves;
- a pressure regulator fitted to the outlet valve of the
- gas cylinder, used to reduce and control gas pressure;
- a flashback arrester to protect cylinders from flashbacks and backfires;
- flexible hoses to convey the gases from the cylinders to the blowpipe;
- non-return valves to prevent oxygen reverse flow into the fuel line and fuel flow into the oxygen line;
- a blowpipe or other burner device where the fuel gas is mixed with oxygen and ignited.



Oxygen Bottom Entry Regulator

LPG Rear Entry Regulator

Twin Hose

Oxygen/LPG Blowpipe +Mixer

Cutting Attachment

Welding Tip

Cutting Nozzle

Hazards and Risk:

The main hazards are from fire and explosion. These are caused by:

- careless handling of a lighted blowpipe resulting in burns to the user or others;
- using the blowpipe too close to combustible material;
- cutting up or repairing tanks or drums which contain or may have contained flammable materials;
- gas leaking from hoses, valves and other equipment;
- misuse of oxygen;
- backfires and flashbacks.

Most of the air conditioner manufacturing plant participating are not well manage the welding/brazing kits that being used in the production line. Oxygen gas cylinder should be secured to prevent falling down.

Gas hoses are in poor condition.

The flame from an oxy/fuel gas blowpipe is a very powerful source of ignition. Many fires have been caused by the careless use of oxy/fuel blowpipes. The flame will quickly ignite any combustible material it comes into contact with: wood, paper, cardboard, textiles, rubber, plastics. Many processes also generate sparks and hot spatter which can ignite these materials. In the assembly line of air conditioner process where the process of adhesive spraying is done near to the area where welding/brazing is taking place is considered high risk. The production lay-out should be modified.

The following precautions will help to prevent fire:

- move the work piece to a safe location for carrying out the hot work process;
- remove any combustible materials (such as flammable liquids, wood, paper, textiles, packaging or plastics) from within about 10 meters of the work;
- ventilate spaces where vapors could accumulate, such as pits or trenches;
- protect any combustible materials that cannot be moved, from close contact with flame, heat, sparks or hot slag. Use suitable guards or covers such as metal sheeting, mineral fiber boards or fire retardant blankets;

- Check that there are no combustible materials hidden behind walls or partitions which could be ignited, particularly if prolonged welding or cutting is planned. Some wall panels contain flammable insulation materials;
- use guards or covers to prevent hot particles passing through openings in floors and walls (doorways, windows, etc.);
- maintain a continuous fire watch during the period of the work, and for at least an hour afterwards;
- Keep fire extinguishers nearby.

There is a risk of fire and explosion if oxy/fuel gas equipment is allowed to leak. Acetylene, Propane and other fuel gases are highly flammable, and form explosive mixtures with air and oxygen. Even small leaks can have serious consequences, particularly if they are leaking into a poorly ventilated room or confined space where the gases can accumulate. A leak of flammable gas could cause a flash fire or explosion. Gas leaks are often the result of damaged or poorly maintained gas control equipment, hoses, blowpipes and valves, poor connections and not closing valves properly after use.

The following precautions will help to prevent leaks:

- keep hoses clear of sharp edges and abrasive surfaces or where vehicles can run over them;
- do not allow hot metal or spatter to fall on hoses;
- handle cylinders carefully. Keep them in an upright position and fasten them to prevent them from falling or being knocked over. For example, chain them in a wheeled trolley or against a wall;
- always turn the gas supply off at the cylinder when the job is finished;
- maintain all equipment and keep in good condition;
- regularly check all connections and equipment for faults and leaks.

Oxygen leaks also increase the fire risk. In particular, if clothing is contaminated with oxygen, it will catch fire easily and burn very fiercely resulting in severe injury. Even fire retardant clothing will burn if contaminated with oxygen. Also oxygen can cause explosions if used with incompatible materials. In particular, oxygen reacts explosively with oil and grease.

Always take the following precautions:

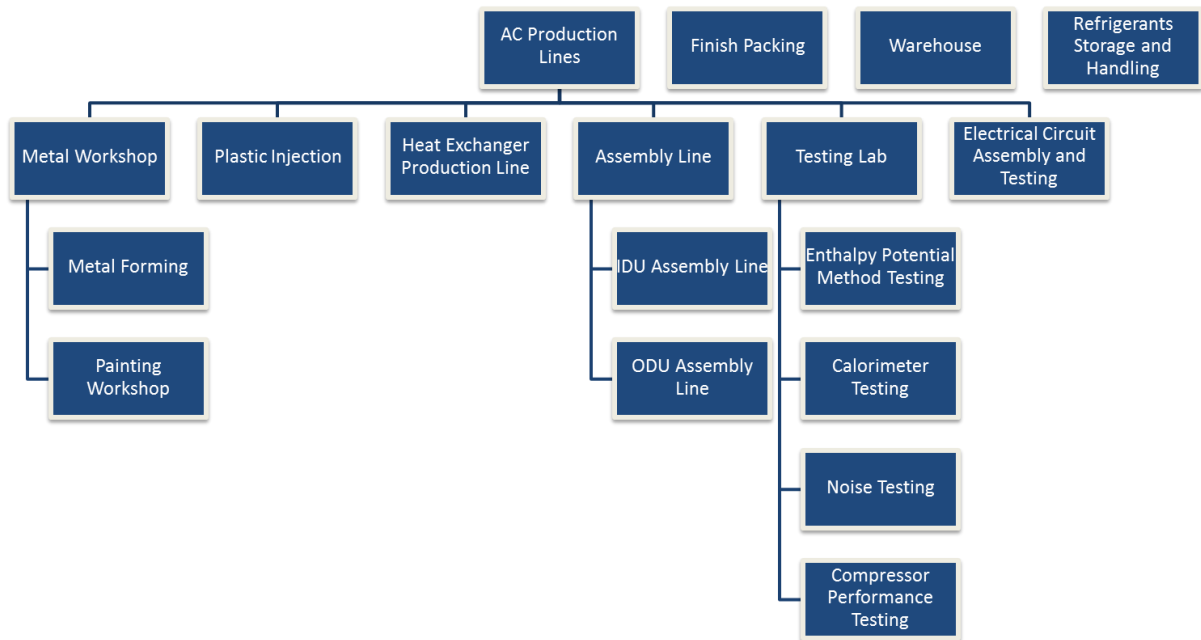
- never allow oil or grease to come into contact with oxygen valves or cylinder fittings;
- never use oxygen with equipment not designed for it. In particular, check that the regulator is safe for oxygen and for the cylinder pressure.

Back Fire and Flash back hazards:

A backfire is when the flame burns back into the blowpipe often with a sharp bang. This may happen when the blowpipe is held too close to the work piece, or if the nozzle is blocked or partly blocked. The flame may go out or it may re-ignite at the nozzle. Sometimes the flame burns back into the blowpipe, and burning continues at the mixing point. Backfires do not usually cause serious injury or damage but they indicate a fault in the equipment.

Flashbacks are commonly caused by a reverse flow of oxygen into the fuel gas hose (or fuel into the oxygen hose), producing an explosive mixture in the hose. The flame can then burn back through the blowpipe, into the hose and may even reach the pressure regulator and the cylinder. The consequences of a flashback are potentially very serious. They can result in damage or destruction of equipment, and could even cause the cylinder to explode. This could end in serious injury to personnel and severe damage to property. To protect a cylinder, you should fit flashback arresters onto the regulator, on both the fuel and oxygen supply. Arresters may be fitted on the blowpipe but these do not give protection from a fire starting in the hose. For long lengths of hose, The arresters should be fitted on both the blowpipe and the regulator.

ANNEX 5 Typical Air-conditioner Production Equipment and Overall Lay-out



Many AC manufacturers have their own metal sheet forming workshop. Metal sheets come in a metal sheet coil which needs to be transferred onto the metal machineries by forklift truck. On manually operated machines, the most dangerous machine movements are the rotating, cutting, shearing, sawing or pressing movements of tools, particularly on:

- presses
- drilling machines
- milling machines
- lathes
- metal cutting saws
- guillotines and Grinding machines.
-

Most accidents at all types of machine, including automatic and CNC machines, happen to operators during normal operation when:

- Loading/unloading coils, die and other components
- Removing jam
- Taking measurements and making adjustments (to the coolant supply in particular).

Hands are most frequently injured, the most numerous injuries being cuts and abrasions, many of which are severe. Broken bones and dislocations are numerous. Amputations of fingers and hands are not infrequent and there are some fatalities, often arising from entanglements, every year. Eye injuries are also common.

On automatic and computer controlled machinery, a larger proportion of accidents happens at automatically and computer controlled clamps, axes, tables, swarf removal equipment, chucks and other work handling equipment. At all types of machinery a large number of accidents happen to setters, electricians and maintenance personnel during set-up, inspection, fault-finding, maintenance and repair. Most ill health arises from: unsafe loading/unloading and handling of components, in particular when highly repetitive, which may cause back injuries and upper limb disorders skin contact with metalworking fluids, for example when preparing fluids or handling components, which may cause skin irritation and dermatitis breathing in aerosols, oil mists and fumes from metalworking fluids during machining which may cause irritation of the eyes, nose and throat, and occasionally breathing difficulties such as bronchitis and asthma sharp edges and swarf which may cause cuts which exacerbate dermatitis high noise levels which may cause deafness most frequently at machines which generate impacts when operating, higher speed machines or groups of machines running together vibration, particularly when grinding.

Safety measures

To prevent access to dangerous movements during batch production at manually operated machines use fixed guards with:

- jigs and fixtures (such as sliding trays) to load and unload components away from the tools
- safe means of removing swarf (such as a hook or rake which may be inserted through small openings in fixed guards) and adjusting coolant (such as taps outside fixed guards).
- Use fixed and interlocking guards or safety devices providing equivalent protection at automatic and CNC machines to ensure all dangerous movements, not only tools, are guarded.
- Control noise by engineering means at source or adapt and extend guards to serve as noise enclosures (eg by lining them with noise absorbent materials).
- Use guards to help enclose and control hazardous substances with LEV where appropriate.
- Manually operated machines used infrequently for one-off operations such as those often found in tool rooms may require constant adjustment and close observation; guards may also need to be readily adjustable and allow close observation.



Two hands button is designed to protect people. However, just a small piece of metal attached into one of them, the machine can run using only one hand to operate. None of machine safeguard can stop the operator to override an injure themselves. Safety awareness and the right set of behavior is the most important things that management shall try to encourage.

Spot Welding



Sparks can fly off from the welding arc. The flying sparks, hot work piece, and hot equipment can cause fires and burns. Accidental contact of electrode to metal objects can cause sparks, explosion, overheating, or fire. Check and be sure the area is safe before doing any welding.

- Remove all flammables within 35 ft (10.7 m) of the weld. If this is not possible, tightly cover them with approved covers.
- Do not spot weld where flying sparks can strike flammable material.
- Protect yourself and others from flying sparks and hot metal.
- Be alert that welding sparks can easily go through small cracks and openings to adjacent areas.
- Watch for fire, and keep a fire extinguisher nearby.
- Do not weld on containers that have held combustibles or on closed containers such as tanks, drums, or pipes unless they are properly prepared.
- Do not weld where the atmosphere may contain flammable dust, gas, or liquid vapors (such as gasoline).
- Remove any combustibles, such as butane lighter or matches, from your person before doing any welding
- After completion of work, inspect area to ensure it is free of sparks, glowing embers, and flames.
- Do not exceed the equipment rated capacity.
- Use only correct fuses or circuit breakers. Do not oversize or bypass them.
- References: OSHA 1910.252 (a) (2) (iv) and NFPA 51B

Common causes of ill health are:

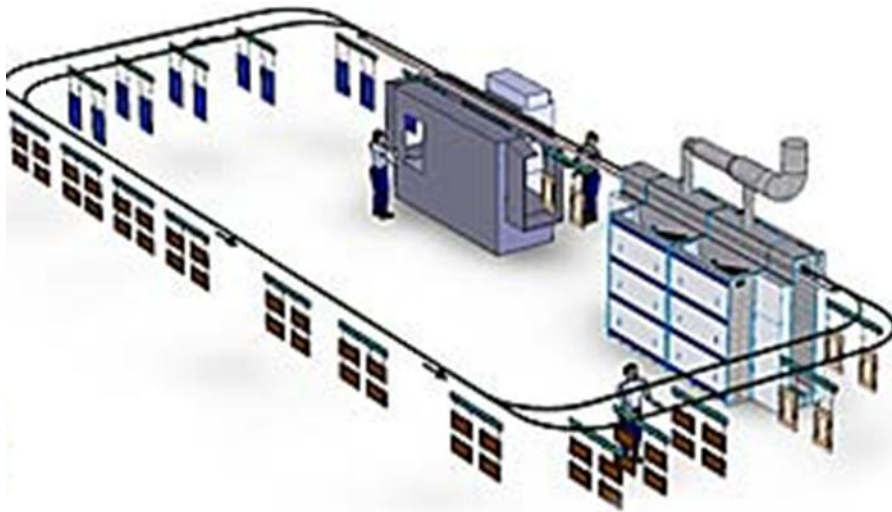
- inhalation of harmful welding fume
- unsafe handling of work pieces and welding equipment, particularly gas cylinders
- noise, particularly from plasma arc cutting, gouging operations and weld preparation
- burn from ultra violet radiation, including 'arc eye'
- vibration during grinding for weld preparation
- Discomfort from heat and uncomfortable postures.
-

Common causes of accidents are

As a result of:

- falling gas cylinders
- particles entering unprotected eyes during chipping after welding
- electric shocks from arc welding equipment
- fires started by flames, sparks and hot material from welding and cutting processes
- fingers being crushed between the electrodes of fixed resistance welding machines.

Powder Coating/ Pain Spraying



Three major steps in a powder coating process or painting.

- Part preparation or the pre-treatment
- The powder application/ pain spraying
- Curing

Removal of oil, soil, lubrication greases, metal oxides, welding scales etc. is essential prior to the powder coating process. It can be done by a variety of chemical and mechanical methods. The selection of the method depends on the size and the material of the part to be powder coated, the type of soil to be removed and the performance requirement of the finished product. Chemical pre-treatments involve the use of phosphates or chromates in submersion or spray application. These often occur in multiple stages and consist of degreasing, etching, de-smutting, various rinses and the final phosphate or chromatin of the substrate. The pre-treatment process both cleans and improves bonding of the powder to the metal. Recent additional processes have been developed that avoid the use of chromates, as these can be toxic to the environment. Titanium zirconium and silanes offer similar performance against corrosion and adhesion of the powder.

The most common way of applying the powder coating to metal objects is to spray the powder using an electrostatic gun, or corona gun. The gun imparts a positive electric charge to the powder, which is then sprayed towards the grounded object by mechanical or compressed air spraying and then accelerated toward the work piece by the powerful electrostatic charge. There are a wide variety of spray nozzles available for use in electrostatic coating. The type of nozzle used will depend on the shape of the work piece to be painted and the consistency of the paint. The object is then heated, and the powder melts into a uniform film, and is then cooled to form a hard coating. It is also common to heat the metal first and then spray the powder onto the hot substrate. Preheating can help to achieve a more uniform finish but can also create other problems, such as runs caused by excess powder.



When a thermoset powder is exposed to elevated temperature, it begins to melt, flows out, and then chemically reacts to form a higher molecular weight polymer in a network-like structure. This cure process, called crosslinking, requires a certain temperature for a certain length of time in order to reach full cure and establish the full film properties for which the material was designed. Normally the powders cure at 200°C (390°F) for 10 minutes. The curing schedule could vary according to the manufacturer's specifications. The application of energy to the product to be cured can be accomplished by convection cure ovens, infrared cure ovens, or by laser curing process. The latter demonstrates significant reduction of curing time.

Powder coating is an alternative finishing process to spray painting. The hazards of using coating powders include:

- direct skin contact with the powders
- breathing in powders in the air
- swallowing powders.
- Some curing or hardening agents used in powders, especially TGIC (triglycidyl isocyanurate) and TMA (tri-mellitic anhydride) can cause direct irritation of the skin, eyes and lungs or allergic skin reactions. There is concern that some curing agents may cause asthma.

The risks of harm occurring are highest when:

- using powders containing curing agents such as TGIC or TMA
- spraying powder in poorly ventilated powder-coating booths
- following poor systems of work, such as leaning into the coating booth when spraying
- carrying out powder transfer, maintenance and cleaning work.
- Other precautions to take include:



Minimize the risk of a fire or explosion by regular cleaning to prevent buildup of dust and exclude sources of ignition, such as naked flames, cigarettes, etc. from powder coating work areas. Minimize the risk of electric shock by ensuring good earthing of work equipment and regular maintenance of electrical equipment. Maintain compressed air systems associated with powder coating equipment Ref. NFPA 68, NFPA 91.

Fire and Explosion Hazard from LPG system



Many air conditioner manufacturing plant has a small LPG manifold system to supply Dry Oven for powder coating and Air drier at the area where coil are undergo pressure testing, bubble test. The LPG pipe also found in the area where brazing and assembly of the heat exchangers are performed. Poor designed manifold, misused of LPG hoses, connectors, regulator, and valves, poor piping installation, lack of maintenance can lead to serious fire accident in those areas.

See more detail on Oxy-Fuel Welding Safety Guideline

Generic Risk Assessment for Heat Exchanger workshop

Tube processing machinery includes

- uncoilers,
- tube straightening cut-to-length machinery,
- return benders,
- elbow bender,
- dual 90 degree 'crossover' benders and 'hairpin' benders.
- CNC/NC benders,
- header punching machinery
- tube end forming machinery.
- multiple fin press sizes,

- progressive fin dies
- fin collectors,
- Vertical coil expansion
- threading devices
- automatic coil brazing machinery
- conveying system to deliver coils after brazing.
- header brazing machinery to braze header pipes.



Key risk associated with operation in Heat Exchanger making process

- Hand and fingers injury. Most injuries occur during activities such as setting/adjustment, swarf removal, or observation for the purpose of process control.
- The largest single cause of injury is entanglement at revolving tools.
- Crushing and trapping hazards at tools and the moving worktable are also very significant causes of injury.
- Injuries are often very severe and include limb and skull fractures and amputations. The potential for fatal injury at these machines should not be underestimated.
- Most ill health arises from: unsafe handling, The unsafe movement of goods by hand, either by lifting or handling causes more accidents and ill health in small engineering workshops than any other single activity, especially to those most at risk, including the younger more inexperienced employees, the older and/or less physically fit, and those who may make an existing injury worse.
- Back injuries are very common as are hand, arm, shoulder and neck injuries, particularly from unsafe, highly repetitive work. Cuts and abrasions from sharp edges are also very numerous harmful metalworking fluids
- Correctly managing your metalworking fluids will reduce the risk of ill health, prolong the life of the fluid, increase tool life, and improve the machining performance.
- Ill health from metalworking fluids, used neat or mixed with water, most commonly arises from: skin contact during preparation, application and removal of fluid handling of work

pieces, splashing when machining changing and setting of tools, maintenance and cleaning of machines causing skin irritation and dermatitis, and breathing in aerosols, mist and fumes when machining causing irritation of the eyes, nose and throat and occasionally breathing difficulties such as bronchitis and asthma.

- As most metalworking fluids, either as concentrates or when in use, are or contain hazardous substances.



Key risk associated with operation in plastic injection process

Accidents at injection molding machines were investigated. Summarizes the operations being undertaken and the types of accident/parts involved are; Injury during normal operation and maintenance/setting core and ejectors, burns and splash, front guard, top guard, discharge area, clamp area, rear guard.

More detailed analysis has shown that most of the accidents were caused by: inadequate safeguarding fitted; the safeguarding had been removed or fallen into disrepair; or the safeguarding had been overridden, usually for setting.



Reference: European Standard BS EN 201:1997

A significant number of accidents have happened because the safety devices supplied with machines have deteriorated in use or have been removed and not replaced. The following minimum checks should be made to ensure that safety is maintained.

- Operational checks (suggested frequency: daily/after mould change)
- Are all fixed and interlocked guards in place and secure?
- Can the platens close when the operator's guard is open?
- Are all control unit enclosures closed, locked and the keys removed?
- If fitted, is the mechanical restraint correctly positioned, particularly after mould change?

Reference:

BS EN 201: 1997 Rubber and plastics machines. Injection moulding machines. Safety requirements

BPF Safety guidance on the guarding and use of injection moulding machines in the plastics and rubber industries 238/3 1991.

British Polymer Training Association Injection molding operator handbook



Key risk associated with operation in refrigerant vacuum and charging process

Air conditioner manufacturing factories are different in terms of size of the business, technology they use for each process, equipment they have in the production lines. Vacuum and charging refrigerant of those manufacturers are different. Some factories have fully automated vacuum and charging equipment which are PLC controlled systems. Small factories use portable simple vacuum pumps and manual feed pumps which are manually operated. No matter how complex the systems are, the similarity is health and safety risk if there is a leak from the equipment. HFC-32 is unlike R-22. It is flammable. When it leaks, no matter what the cause, it will form a flammable mixture in the air and wait for an ignition source to set it on fire. Basically, none of the air conditioner manufacturing sites have the procedure to classify hazardous zones at all. Therefore, there is no control on ignition sources in the area where the refrigerant is handled. The risk of injury due to extremely cold burns from direct contact with leaking refrigerant has not been aware of, as most of the sites fail to enforce PPE rules in this particular area. No workers were wearing gloves and safety goggles when doing this task. These are the common potential problems in the air conditioner manufacturing observed during due diligence site visits; Poor arrangement of refrigerant storage area. No separation between different types of refrigerant, oxygen, and LPG. Poor manifold, regulators, header, hoses and connectors arrangement. These parts are used in pressurized systems, positive or negative; the faulty parts at any location of refrigerant will cause the leak. Poor method of handling the cylinder from one point to another point was observed. Free standing cylinders are always seen at most sites. The area for vacuum and charging is located right next to the location where naked flames from brazing are taking place, electrical extension cords, plugs, and other electrical ignition sources are in the proximity where flammable mixtures are ready to be ignited if they leak. Poor housekeeping as walkways, emergency exits, are blocked, obstructed. Inconsistent leak test procedures after the unit is charged. Some factories run 100% leak checks with electronic leak detection devices but some don't. There are no strict controls of maintenance jobs that can cause wrong modifications on the elements of pressurized parts; there is no control strictly on hot work activity. Lack of safe standards for manifold, valves, and piping labeling. Poor maintenance and poor calibration on equipment and tools with standard gas.

ANNEX 6 Summary of Laws and Regulations for Air Conditioner Sector Enterprises

| Concerned Processes/Chemicals | Name of Laws / Regulations | Brief Description of Laws / Regulations |
|--|---|---|
| Workplace, building and Structure Safety and Fire Protection | Factory Act B.E. 2535 by Ministry of Industry | <p>Section 1 clause 18(2) of Factory Act B.E. 2535</p> <p>Section 8: For the purpose of control of the engagement in a factory business, the Minister shall have the power to prescribe the ministerial rules with which any or all groups of factory under Section 7 must comply with respect to the following matters.</p> <p>(1) To adopt the criteria relating to the location of factory, environment of the factory, nature of the buildings of factory, or interior nature of the factory.</p> <p>(2) To adopt the nature, type, or kind of machines, equipment or such other things as to be used for the engagement in a factory business.</p> <p>(3) To adopt the requirements of specialized workers according to the type kind, or size of factory to perform duty for such factory.</p> <p>(4) To adopt the criteria to be followed, process of production and provision of other equipment or tools in order to prevent or stop or mitigate the dangers, injuries, or troubles that may cause to the persons or property in the factory or its vicinity.</p> <p>(5) To adopt the standards and methods of controlling the discharge of wastes, pollutants or anything that affects the environment as a result of the engagement in a factory business.</p> <p>(6) To adopt the provision of required documents for the factory for the purpose of controlling and inspection the compliances with the laws.</p> <p>(7) To adopt the required information relating to the engagement in a factory business of which a person engaging in a factory business must inform, from time to time or in a specified period.</p> <p>(8) To adopt any other requirements for the protection of safety in the operations in order to prevent or stop or mitigate the dangers or injuries that may result from the engagement in a factory business.</p> <p>Section 12: A person engaging in a factory business of group 3 must obtain a permit from the Grantor and must comply with the criteria provided for in the ministerial rules prescribed pursuant to Section 8, the Notification of the Minister prescribed pursuant to the said ministerial rules and the Notification of the Minister prescribed pursuant to Section 32.</p> <p>Section 18: A recipient of a permit may not expand the factory unless permitted by the Grantor.</p> <p>Section 12, Section 13, and Section 16 shall apply mutatis mutandis to the application for expansion of the factory and the grant thereof including the appeal of the order refusing such expansion.</p> |

| Concerned Processes/Chemicals | Name of Laws / Regulations | Brief Description of Laws / Regulations |
|-------------------------------|--|--|
| | <p>Notification of the Ministry of Industrial Subject: Factory Fire Prevention and Control B.E. 2552</p> | <p>Section 2: Fire Alarm System Especially the area that none of employee works, electrical installation and using area, Flammable or combustible materials including detection system and automatic fire alarm system. The Fire Alarm System has to be electrical backup system at least 2 hours, which should be separate with electrical supply to normal lighting and machine.</p> <p>Section 3: Fire Extinguisher 7) The tare weight of fire extinguisher at least 4.5 k.g. and ready to extinguish fire at any time, inspection period at least 6 months. 9) Distance between each of fire extinguisher is less than 20 meters and the top height from ground floor level at least 1.50 meter including safety sign, non-obstruct materials and easy access and egress to reach the fire extinguisher.</p> <p>Section 4: Fire Water System 10) Prepare fire water for supply to firefighting equipment at least 30 minutes.</p> <p>Section 5: Automatic Fire Extinguisher System 12) Combustible Raw materials or product storage area at least 1,000 m², this storage area is required automatic fire extinguisher system installation i.e. automatic sprinkler system, or any equalization system that covered this storage area. 14) Flammable materials storage area at least 14 m², this storage area is required automatic fire extinguisher system installation, that has to be suitable with the condition at this storage area.</p> <p>Section 6: Inspections and Preventive Maintenance 15) Inspections and preventive maintenance program is in place, the requirement as of this Notification of the Ministry of Industrial.</p> <p>Section 7: Fire Prevention and Control training 17) Provide fire prevention and control training for employees and records keeping</p> <p>Section 8: others 18) Opening walls, floors, beams and pipe penetration shall be seal with fire resistance materials that has minimum fire resistance for 2 hours. 19) Combustible raw materials, products or flammable materials storage area has to be isolated with fire a resistance material that has minimum fire resistance for 1 hour. 20) One storey building with the metal structure has to be covered with fire a resistance material that has minimum fire resistance for 1 hour. Many storey building with the metal structure has to be covered with fire a resistance material that has minimum fire resistance for 2 hour. 21) Hot work permit system has to be implemented. 22) Provide fire evacuation route to evacuate all employees to safe location at least 5 minutes. 23) Combustible materials storage which are not storage on the pallet rack should not be stack higher than 6 meters and keep the distance of the top layer to the lamp on the roof at least 60 c.m.</p> |

| Concerned Processes/Chemicals | Name of Laws / Regulations | Brief Description of Laws / Regulations |
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| | Ministerial Regulation of Occupation Safety, Health and Environmental Standards for Fire Prevention and Control B.E. 2555 | <p>24) Machine, equipment, storage tanks, reactor or any process that containing with flammable substance shall be bonded and grounded for electro-static discharge.</p> <p>25) Flammable substance storage handling shall be complied with the guidance provide on Safety Data Sheet.</p> <p>26) Assign the employee to be safety responsible person of factory and conduct fire safety inspections at least monthly.</p> <p>27) Provide fire prevention and control plan including fire safety inspections plan, fire prevention and control plan and fire evacuation plan.</p> <p>Section 1: General</p> <p>2) Provide Fire Prevention and Control System within an effetyly and safely condition.</p> <p>3) Provide the fire protection equipment and evacuation route signs.</p> <p>4) Fire Prevention and Control Plan is implemented; including inspection, training, promotion, prevention, control, evacuate and recovery.</p> <p>6) Conduct Standards Operating Procedure (SOP) prior fire risk task will be assigned.</p> <p>7) - Combustible materials shall separate storage area. - Absorb water materials shall storage at the ground floor.</p> <p>Section 2: Building and Fire Evacuation Route Safety</p> <p>Section 3: Extinguish Fire</p> <p>Section 4: Fire Protection from Heat Radiation</p> <p>Section 5: Flammable and Explosive Materials</p> <p>Section 6: Combustible or Flammable Waste Disposal</p> <p>Section 7: Lightning Hazard Prevention</p> <p>Section 8: Fire Safety Implementation and Reporting</p> <p>27) Conduct Basic Fire Fighting at least 40% of the total number of employees by authorized training center approval from Welfare and Labor Protections Department</p> <p>28) 1. Fire prevention and control management team and director, shall be available at any time while operating activities. 2. Conduct fire prevention and control, fire extinguish equipment usage, first aid and rescue training for fire prevention and control personnel.</p> <p>29) All Employees shall involve on Evacuation Exercise at least annually</p> |
| | Notification of the Ministry of Welfare and Labor Protection Subject: Portable Fire Extinguisher Standards B.E. 2556 | <p>2) Portable Fire Extinguisher Standards B.E. 2556 refers to National Fire Protection Association (NFPA), American National Standards Institute (ANSI), Australia Standards (AS), British Standard (BS) and International Standardization and Organization (ISO)</p> |
| | Ministerial Regulation on the | <p>“Working Condition” means the environment as it appears in the employee’s working premises</p> |

| Concerned Processes/Chemicals | Name of Laws / Regulations | Brief Description of Laws / Regulations |
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| <p data-bbox="181 256 450 997"></p> <p data-bbox="181 1153 450 1214">Plant Equipment, Machineries Safety</p> | <p data-bbox="479 256 864 997">Prescribing of Standard for Administration and Management of Occupational Safety, Health and Environment in Relation to Heat, Light and Noise B.E. 2549 (2006) by Minister of Labor</p> <p data-bbox="479 1002 864 1214">Notification of the Ministry of Industry Subject: Define Nuisance Noise and Noise Level of Factory Operating B.E. 2548 Factory Act B.E. 2535 by Ministry of Industry</p> | <p data-bbox="902 256 2078 320">including various conditions in the working areas, machinery, buildings, location, air ventilation, heat, light, noise, and as well as conditions and working characteristics of an employee.</p> <p data-bbox="902 325 2078 352">Chapter 1: Heat</p> <p data-bbox="902 357 2078 416">Clause 3: The employer shall control and maintain the heat level within the workplace in which employees are working not to exceed the standard.</p> <p data-bbox="902 421 2078 448">Chapter 2: Light</p> <p data-bbox="902 453 2078 480">Clause 5: The employer shall provide the intensity of light at the workplace.</p> <p data-bbox="902 485 2078 512">Chapter 3: Noise</p> <p data-bbox="902 517 2078 592">Clause 8: An employer shall control the Time Weighted Average - TWA of noise level received by an employee not to exceed the standard as prescribed in Table 6 annexed to this Ministerial Regulation.</p> <p data-bbox="902 596 2078 624">Chapter 4: Personal Protective Equipment</p> <p data-bbox="902 628 2078 655">Clause 13: Personal protective equipment shall be of standard.</p> <p data-bbox="902 660 2078 687">Chapter 5: Measurement and Analysis of Working Conditions</p> <p data-bbox="902 692 2078 751">Clause 15: An employer shall conduct measurement and analysis of working conditions in relation to heat, light or noise within the workplace.</p> <p data-bbox="902 756 2078 783">Chapter 6: Health Checkup and Report on Result of the Health Checkup</p> <p data-bbox="902 788 2078 863">Clause 20: An employer shall arrange health checkup for employees who work in the working conditions that may be harmful by heat, light or noise, according to the criteria and method as prescribed in the Notification by the Director-General.</p> <p data-bbox="902 868 2078 991">Clause 12: In case the working condition of the workplace has noise level, to which an employee is exposed by average throughout eight working hours, from eighty five decibel A upward, the employer shall introduce a project for hearing preservation in the workplace according to the criteria and method as prescribed by the Director-General.</p> <p data-bbox="902 995 2078 1023">Define Nuisance Noise and Noise Level of Factory Operating</p> <p data-bbox="902 1155 2078 1182">Section 1: clause 18(2) of Factory Act B.E. 2535</p> <p data-bbox="902 1187 2078 1262">Section 8: For the purpose of control of the engagement in a factory business, the Minister shall have the power to prescribe the ministerial rules with which any or all groups of factory under Section 7 must comply with respect to the following matters.</p> <p data-bbox="902 1267 2078 1326">(1) To adopt the criteria relating to the location of factory, environment of the factory, nature of the buildings of factory, or interior nature of the factory.</p> <p data-bbox="902 1331 2078 1358">(2) To adopt the nature, type, or kind of machines, equipment or such other things as to be used for</p> |

| Concerned Processes/Chemicals | Name of Laws / Regulations | Brief Description of Laws / Regulations |
|-------------------------------|--|--|
| | Occupational Safety, Health and Environment Act B.E. 2554 by Ministry of Labor and Welfare | <p>the engagement in a factory business.</p> <p>(3) To adopt the requirements of specialized workers according to the type kind, or size of factory to perform duty for such factory.</p> <p>(4) To adopt the criteria to be followed, process of production and provision of other equipment or tools in order to prevent or stop or mitigate the dangers, injuries, or troubles that may cause to the persons or property in the factory or its vicinity.</p> <p>(5) To adopt the standards and methods of controlling the discharge of wastes, pollutants or anything that affects the environment as a result of the engagement in a factory business.</p> <p>(6) To adopt the provision of required documents for the factory for the purpose of controlling and inspection the compliances with the laws.</p> <p>(7) To adopt the required information relating to the engagement in a factory business of which a person engaging in a factory business must inform, from time to time or in a specified period.</p> <p>(8) To adopt any other requirements for the protection of safety in the operations in order to prevent or stop or mitigate the dangers or injuries that may result from the engagement in a factory business.</p> <p>Section 12: A person engaging in a factory business of group 3 must obtain a permit from the Grantor and must comply with the criteria provided for in the ministerial rules prescribed pursuant to Section 8, the Notification of the Minister prescribed pursuant to the said ministerial rules and the Notifications of the Minister prescribed pursuant to Section 32.</p> <p>Section 18: A recipient of a permit may not expand the factory unless permitted by the Grantor.</p> <p>Section 12, Section 13, and Section 16 shall apply mutatis mutandis to the application for expansion of the factory and the grant thereof including the appeal of the order refusing such expansion.</p> <p>Section 16: An Employer shall provide an occupational safety, health and environment training to be attended by an Executive, a Supervisor and an Employee in order to safely administer, manage and operate the occupational safety, health and environment.</p> <p>Whereas the Employer employs an Employee to work, changes work, changes workplace or changes machinery or equipment that may be harmful to life, physique, mentality and health of the Employee, the Employer shall provide training for every Employee before commencing work. The training under paragraph one and paragraph two shall be in conformity with criteria, methods or terms as stipulated by the Director-General.</p> <p>Section 19: Whereas an Employer rents a building, premise, tool, machinery, equipment or any others to be used in an establishment, the Employer shall have powers to carry out an operation on occupational safety, health and environment involving with the rend building, premise, tool, machinery, equipment or any others in accordance with the standards as prescribed in the Ministerial Regulation issued under Section 8.</p> |

| Concerned Processes/Chemicals | Name of Laws / Regulations | Brief Description of Laws / Regulations |
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| | | <p>Chapter 2: Administration, Management and Operation on Occupational Safety, Health and Environment</p> <p>Section 8: An Employer is required to administer, manage and operate the occupational safety, health and environment in conformity with the standards prescribed in the Ministerial Regulation. In setting the standards under paragraph one, the Employer shall provide document or report examined or certified by person or juristic person as prescribed in the Ministerial Regulation. An Employee is obligated to comply with criteria on occupational safety; health and environment in accordance with the standards prescribed in paragraph one.</p> <p>Chapter 4: Control, Supervision and Administration</p> <p>Section 32: For the purpose of control, supervision and administration operations on occupational safety, health and environment, an employer shall perform as follows:</p> <ol style="list-style-type: none"> (1) To conduct hazard assessment; (2) To conduct study on impacts of working conditions which have an effect on employee; (3) To prepare operation plan on occupational safety, health and environment and supervisory plan for employee and the establishment (4) To submit results on hazard assessment, impact study, operation plan and supervisory plan under (1), (2) and (3) to the Director-General or a person entrusted by the Director- General. <p>Criteria, methods and conditions on performance under paragraph one, type of business, size of business required to be operated and operation period shall be as per prescribed by the Minister published in the Government Gazette.</p> <p>In performing the work under paragraph one, the employer shall comply with recommendations of and results shall have been certified by the expert on occupational safety, health and environment.</p> <p>Section 36: Whereas a Safety Inspector has found that an Employer, an Employee or any concerned person has violated or failed to comply with this Act or the Ministerial Regulation issued under this Act or has found that the working conditions, buildings, premises, machinery or equipment used by the Employee may be dangerous to the Employee, the Safety Inspector shall have the power to order such person to stop such violating acts or to correct, improve or conform correctly or properly within thirty days. If there is necessary cause which prevents such operation to be able to be completed within such period, the Safety Inspector may extend such period not more than twice, each with thirty days from the due date of such period.</p> <p>In case it is necessary, upon permission of the Director-General or a person entrusted by the Director-General, the Safety Inspector shall have the power to order to stop the usage of machinery or equipment, building, premise or to bind and stamp on material which may cause severe danger to such Employee, in whole or in part, during the compliance with the order of the Safety Inspector. When the Employer has corrected and improved to conform correctly to order of Safety Inspector under paragraph one, the Employer shall inform the Director-General or person entrusted by the</p> |

| Concerned Processes/Chemicals | Name of Laws / Regulations | Brief Description of Laws / Regulations |
|-------------------------------|---|---|
| | Ministerial Regulation of Occupation Safety, Health and Environmental Standards for Machinery, Crane and Boiler B.E. 2552 by Ministry of Labor and Welfare | <p>Director-General for the consideration on revocation of such order.</p> <p>Chapter 1: Machineries</p> <p>Clause 1: General</p> <p>Clause 2: Metal Pressed Machineries</p> <p>Clause 3: Electrical and Gases Welding Machineries</p> <p>Clause 4: Forklift Trucks</p> <p>Clause 5: Elevators</p> <p>Chapter 2: Cranes</p> <p>Clause 1: General</p> <p>Clause 2: Overhead Cranes and Tower Cranes</p> <p>Clause 5: Crane Equipment and Devices</p> <p>Chapter 4: Personal Protective Equipment</p> |
| | Ministerial Regulation on the Prescribing of Standard for Administration and Management of Occupational Safety, Health and Environment in Relation to Heat, Light and Noise B.E. 2549 (2006) by Minister of Labor | <p>“Working Condition” means the environment as it appears in the employee’s working premises including various conditions in the working areas, machinery, buildings, location, air ventilation, heat, light, noise, and as well as conditions and working characteristics of an employee.</p> <p>Chapter 1: Heat</p> <p>Clause 3: The employer shall control and maintain the heat level within the workplace in which employees are working not to exceed the standard.</p> <p>Chapter 2: Light</p> <p>Clause 5: The employer shall provide the intensity of light at the workplace.</p> <p>Chapter 3: Noise</p> <p>Clause 8: An employer shall control the Time Weighted Average - TWA of noise level received by an employee not to exceed the standard as prescribed in Table 6 annexed to this Ministerial Regulation.</p> <p>Chapter 4: Personal Protective Equipment</p> <p>Clause 13: Personal protective equipment shall be of standard.</p> <p>Chapter 5: Measurement and Analysis of Working Conditions</p> <p>Clause 15: An employer shall conduct measurement and analysis of working conditions in relation to heat, light or noise within the workplace.</p> <p>Chapter 6: Health Checkup and Report on Result of the Health Checkup</p> <p>Clause 20: An employer shall arrange health checkup for employees who work in the working conditions that may be harmful by heat, light or noise, according to the criteria and method as prescribed in the Notification by the Director-General.</p> <p>Clause 12: In case the working condition of the workplace has noise level, to which an employee is exposed by average throughout eight working hours, from eighty five decibel A upward, the employer shall introduce a project for hearing preservation in the workplace according to the criteria</p> |

| Concerned Processes/Chemicals | Name of Laws / Regulations | Brief Description of Laws / Regulations |
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| Electrical System | Ministerial Regulation of Occupation Safety, Health and Environmental Standards for Electrical System B.E. 2554 by Ministry of Labor and Welfare Ministerial Regulation of Factory Electrical Safety Measurement B.E. 2550 by Ministry of Industry | and method as prescribed by the Director-General. Section 1: General Section 2: Electrical Apparatus Section 3: Lightning Protection Section 4: Personal Protective Equipment and Safety Devices or Equipment for Prevention electrical hazards Clause 1: Definition of electrical system Clause 2: As built drawing shall be available in factory Clause 3: Electrical Apparatus and devices shall be compliance with Industrial Standards or International Standards Clause 4: Electrical usage in factor shall compliance with acceptable principle, standards, requirement, method and condition. Clause 5: Electrical System Safety Inspection and Certified by authorized person. Clause 7: Records Keeping of Clause 2 and Clause 5 |
| Health and Hygiene | Ministerial Regulation on the Prescribing of Criteria and Method of Conducting Health Checkup of Employees and Forwarding the results of health checkup to labor inspector B.E. 2547(A.D.2004) by Ministry of Labor and Welfare | Clause 2: In this Ministerial Regulation “Health Checkup” means the physical and mental states checkup according to medical method as to ascertain the suitability of and the work-related effects on health of the employees. “Risk-factor-related work” means the work which the employee performs in relation to: (1) Hazardous chemical substances as prescribed in the Announced of the Minister. (2) Toxic microbe which may be a virus, bacteria, fungus or other biological organisms as prescribed in the Announced of the Minister. (3) Radioactivity (4) Heat, cold, vibration, atmospheric pressure, light, noise or other environments which may be hazardous; for this purpose, as prescribed in the Announced of the Minister. Chapter 1: Health Checkup Clause 3: For the employees who work with risk factors, the employer shall provide health checkup to be conducted by a licensed medical practitioner who is specialized in occupational medicine; or who has undergone a training on occupational medicine; or who possesses the qualifications as prescribed in the Notification by the Director-General by completing the first health checkup for employees within thirty days from the first day the employee is employed; and the subsequent health checkup shall be conducted at least once a year. In case the characteristics or the condition of work is related to risk factors and needs health checkup in different period of time, the employer shall avail health checkup for the employees according to such period. In case the employer changes the employee’s dangerous job to be a different one, the employer shall provide health checkup for such employees within thirty days from the date of the job change. |

| Concerned Processes/Chemicals | Name of Laws / Regulations | Brief Description of Laws / Regulations |
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| | | <p>Clause 4: In case the employee is absent from work for consecutive three days due to accident or illness irrespective of circumstance, the employer may request medical explanation from the physician who conducts treatment, or from the physician attached to the establishment, or provide health checkup for the employee before allowing the employee to resume the work.</p> <p>Chapter 2: Recording, Reporting and Forwarding the Results of Health Checkup</p> <p>Clause 5: For the purpose of health checkup of the employee pursuant to Clause 3, the medical practitioner who conducts a health checkup shall record the details of the results of health check up by indicating the practitioner's explanation about health condition of the employee that may affect, or pose obstacles to the work or to the characteristics of the Employee's assigned work; together with the signature of the practitioner who gives treatment and medical explanation on the date of the check up or of giving such medical explanation.</p> <p>Clause 6: The employer shall provide personal Health Report Book of the employee who is working with the risk factors according to the format prescribed in the Notification by the Director-General; and the employer shall record the results of every health check up in the employee's Health Report Book.</p> <p>Clause 7: The employer shall keep the records of employee's health checkup pursuant to Clause 3 including relevant information to be ready for inspection by a labor inspector at all times. The record of each employee shall be kept at the employer's office for not less than two years as from the date of employment termination, unless there is a complaint that the employer has not complied with the law; or there is a lawsuit in relation to any disease or any hazard to the employee's health. In that case, even though the specified time has expired, the employer shall be required to keep such document until the final judgment concerning the said matter is settled. In this regard, the employer shall not be permitted to use such information in the way that is unreasonably detrimental to the employee.</p> <p>Clause 8: The employer shall inform the result of health check up to the employee as follows: (1) In case the health checkup result is not normal, the employee shall be informed within three days from the date of acknowledgement of the result; (2) In case the health checkup result is normal, such employee shall be informed within seven days from the date of acknowledgement of the result;</p> <p>Clause 9: In case of such abnormality of the employee is detected; or the employee is developing a symptom or illness relating to work, the employer shall arrange for the employee to receive medical treatment immediately; and further carry out an inspection or find out the cause of abnormality for prevention purposes. The employer shall forward the results of the health checkup of the employee whose abnormality or illness has been detected; whose medical treatment and prevention or remedy has been provided; to the labor inspector according to the format prescribed by the Director-General within thirty days as from the date of acknowledgement of the abnormality or</p> |

| Concerned Processes/Chemicals | Name of Laws / Regulations | Brief Description of Laws / Regulations |
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| Emergency Preparedness and Response | <p>Notification of the Ministry of Welfare and Labor Protection Subject: Employees Health Booklet and the format of Risk Factor Health Checkup results for abnormal or Occupational illness employees, treatment and corrective and preventive actions B.E. 2551</p> <p>Notification of the Ministry of Industrial Subject: Factory Fire Prevention and Control B.E. 2552</p> | <p>illness. Clause 10: If any employee has medical evidence from the government hospital or the hospital recognized by the government showing that the employee shall not be able to perform work in the same duty, the employer shall proceed to change such job for the employee as to the importance of employee's health and safety. Clause 11: The employer shall give the personal Health Report Book to the employee upon termination of employment. Clause 3: Employees Health Booklet Clause 4: The form of Risk Factor Health Checkup results for abnormal or Occupational illness employees, treatment and corrective and preventive actions</p> <p>Section 2: Fire Alarm System Especially the area that none of employee works, electrical installation and using area, Flammable or combustible materials including detection system and automatic fire alarm system. The Fire Alarm System has to be electrical backup system at least 2 hours, which should be separate with electrical supply to normal lighting and machine. Section 3: Fire Extinguisher 7) The tare weight of fire extinguisher at least 4.5 k.g. and ready to extinguish fire at any time, inspection period at least 6 months. 9) Distance between each of fire extinguisher is less than 20 meters and the top height from ground floor level at least 1.50 meter including safety sign, non-obstruct materials and easy access and egress to reach the fire extinguisher. Section 4: Fire Water System 10) Prepare fire water for supply to firefighting equipment at least 30 minutes. Section 5: Automatic Fire Extinguisher System 12) Combustible Raw materials or product storage area at least 1,000 m2, this storage area is required automatic fire extinguisher system installation i.e. automatic sprinkler system, or any equalization system that covered this storage area. 14) Flammable materials storage area at least 14 m2, this storage area is required automatic fire extinguisher system installation, that has to be suitable with the condition at this storage area. Section 6: Inspections and Preventive Maintenance</p> |

| Concerned Processes/Chemicals | Name of Laws / Regulations | Brief Description of Laws / Regulations |
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| | | <p>15) Inspections and preventive maintenance program is in place, the requirement as of this Notification of the Ministry of Industrial.</p> <p>Section 7: Fire Prevention and Control training</p> <p>17) Provide fire prevention and control training for employees and records keeping</p> <p>Section 8: others</p> <p>18) Opening walls, floors, beams and pipe penetration shall be seal with fire resistance materials that has minimum fire resistance for 2 hours.</p> <p>19) Combustible raw materials, products or flammable materials storage area has to be isolated with fire a resistance material that has minimum fire resistance for 1 hour.</p> <p>20) One storey building with the metal structure has to be covered with fire a resistance material that has minimum fire resistance for 1 hour.</p> <p>Many storey building with the metal structure has to be covered with fire a resistance material that has minimum fire resistance for 2 hour.</p> <p>21) Hot work permit system has to be implemented.</p> <p>22) Provide fire evacuation route to evacuate all employees to safe location at least 5 minutes.</p> <p>23) Combustible materials storage which are not storage on the pallet rack should not be stack higher than 6 meters and keep the distance of the top layer to the lamp on the roof at least 60 c.m.</p> <p>24) Machine, equipment, storage tanks, reactor or any process that containing with flammable substance shall be bonded and grounded for electro-static discharge.</p> <p>25) Flammable substance storage handling shall be complied with the guidance provide on Safety Data Sheet.</p> <p>26) Assign the employee to be safety responsible person of factory and conduct fire safety inspections at least monthly.</p> <p>27) Provide fire prevention and control plan including fire safety inspections plan, fire prevention and control plan and fire evacuation plan.</p> |
| | <p>Ministerial Regulation of Occupation Safety, Health and Environmental Standards for Fire Prevention and Control B.E. 2555</p> | <p>Section 1: General</p> <p>2) Provide Fire Prevention and Control System within an effetely and safely condition.</p> <p>3) Provide the fire protection equipment and evacuation route signs.</p> <p>4) Fire Prevention and Control Plan is implemented; including inspection, training, promotion, prevention, control, evacuate and recovery.</p> <p>6) Conduct Standards Operating Procedure (SOP) prior fire risk task will be assigned.</p> <p>7) - Combustible materials shall separate storage area. - Absorb water materials shall storage at the ground floor.</p> <p>Section 2: Building and Fire Evacuation Route Safety</p> <p>Section 3: Extinguish Fire</p> |

| Concerned Processes/Chemicals | Name of Laws / Regulations | Brief Description of Laws / Regulations |
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| | <p>Notification of the Ministry of Welfare and Labor Protection Subject: Portable Fire Extinguisher Standards B.E. 2556</p> <p>Notification of the Ministry of Industry Subject: Industrial Standards of Lamp for emergency exit signs of indoor building</p> <p>Notification of the Ministry of Welfare and Labor Protection Subject: Basic Fire Fighting Practice and Fire Evacuation Exercise Requirement B.E. 2556</p> <p>Notification of the Ministry of Industry Subject: Hazardous Substances Land Transportation B.E. 2546 Refers to Notification of the Hazardous Substances Land and Transportation B.E. 2546</p> | <p>Section 4: Fire Protection from Heat Radiation Section 5: Flammable and Explosive Materials Section 6: Combustible or Flammable Waste Disposal Section 7: Lightning Hazard Prevention Section 8: Fire Safety Implementation and Reporting 27) Conduct Basic Fire Fighting at least 40% of the total number of employees by authorized training center approval from Welfare and Labor Protections Department 28) 1. Fire prevention and control management team and director, shall be available at any time while operating activities. 2. Conduct fire prevention and control, fire extinguish equipment usage, first aid and rescue training for fire prevention and control personnel. 29) All Employees shall involve on Evacuation Exercise at least annually 2) Portable Fire Extinguisher Standards B.E. 2556 refers to National Fire Protection Association (NFPA), American National Standards Institute (ANSI), Australia Standards (AS), British Standard (BS) and International Standardization and Organization (ISO)</p> <p>Industrial Standards of Lamp for emergency exit signs of indoor building.</p> <p>Basic Fire Fighting Practice and Fire Evacuation Exercise Requirement form refers to this Notification.</p> <p>Section 5: Prior Hazardous Substance Land Transportation, the role and responsibilities of transporter shall be; (1) Provide Safety and Emergency Response Equipment on Prime mover.</p> |

| Concerned Processes/Chemicals | Name of Laws / Regulations | Brief Description of Laws / Regulations |
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| Discharge, Emission and Waste Management | Notification of the Ministry of Industry number 2 subject: Characteristic of Waste Water Discharged from Factory B.E. 2539 | The Characteristic of Waste Water Discharged from Factory has been defined in Notification of the Ministry of Industry number 2 |
| | Notification of the Ministry of Industry subject: Waste or Unused Materials Management B.E. 2548 | The Waste or Unused Materials Management has been implemented referred to Waste or Unused Materials Management B.E. 2548. |
| | Notification of the Ministry of Industry subject : Hazardous Waste Manifest Transport Documentation System B.E. 2547 | The Hazardous Waste disposal transportation acuties has been implemented the Hazardous Waste Manifest Transport documentation system refer to Notification of the Ministry of Industry subject: Hazardous Waste Manifest Transport Documentation System B.E. 2547. |
| | Notification of the Ministry of Industry Subject: Waste Water System of Factory shall be installed devices or specials devices (number 1) B.E. 2547 | If any factory has waste water system, that factory shall provide devices or special devices refer to Waste Water System of Factory shall be installed devices or specials devices (number 1) B.E. 2547 |
| | Notification of the Ministry of Industry Subject: Waste Water System of Factory shall be installed devices or specials devices or additional devices (number 2) B.E. 2548 | If any factory has waste water system, that factory shall provide devices or special devices or additional devices refer to Waste Water System of Factory shall be installed devices or specials devices or additional devices (number 2) B.E. 2548 |
| | Notification of the Ministry of Industry Subject: Waste Water System of Factory shall be installed devices or specials devices or additional devices (number 3) B.E. 2549 | Expand installation due date to be 31 st December B.E. 2551 |
| | Notification of the Ministry of Industry Subject: Defined quantity of air emission from the factory B.E. | “Air emission” means any air that vent from stack or chimney vent duct from factory that is passed from air emission treatment system or not refer to Notification of the Ministry of Industry, Subject: Defined quantity of air emission from the factory B.E. 2549 |

| Concerned Processes/Chemicals | Name of Laws / Regulations | Brief Description of Laws / Regulations |
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| | 2549 Notification of the Ministry of Industry Subject: Provide types and quantities of pollutant that has been vented or drained from factory B.E. 2550 Notification of the Ministry of Natural Resources and Environment Subject: Define the standards control of air emission from factory | Waste water drainage system and air emission from the factory has been report the types and quantities to Ministry of Industry refer to Notification of the Ministry of Industry Subject: Provide types and quantities of pollutant that has been vented or drained from factory B.E. 2550 "Manufacturing Factory" means the classified as Group 2 and Group 3 factory refers to Factory Act B. E. 2535 |

ANNEX 7 Summary of Project Stakeholder Consultation of Environmental Management Plan for the Air-conditioning Sector

September 6, 2013, 13:30 PM – 16:30 PM
Department of Industrial Works

1. Introduction

The Project Stakeholder Consultation of Environmental Management Plan (EMP) for the Air-conditioning (AC) Sector under HCFC Phase out Project was organized at the Department of Industrial Works (DIW) on September 6, 2013 during 13.30 pm-16.30 pm. The main objective of this consultation workshop was to present the content and goal of EMP for 12 AC manufacturers and proposed mitigation measures for the conversion from HCFC-22 to HFC-32 refrigerant.

There were 33 participants from concerned agencies attending in the consultation workshop. These agencies are 12 AC manufacturing enterprises that will be converting to HFC-32 technology, Air conditioning and Refrigeration Industry Club of the Federation of Thai Industries (FTI), manufacturer of compressor, Daikin Industries (Thailand), Treaties and International Strategies Bureau of DIW, Industrial Cluster 4 Bureau of DIW and the Department of Public Works and Town & Country Planning.

2. Welcoming Remark

A warm welcome remark has been made to open the consultation meeting. The meeting encouraged participants to hear outcomes of EMP preparation and proposed mitigation measures for the conversion to HFC-32 in the AC sector. The meeting urged participants to provide suggestions/recommendations, based on their experiences and knowledge, to ensure that conversion to HFC-32 technology would not have any adverse affects to the safety of the enterprises.

3. Background and Objectives

The HCFC Phase out Management Plan (HPMP) Stage I was formulated by DIW with assistance from the World Bank with the main objective to assist Thailand to comply with the Montreal Protocol HCFC phase out obligations. The Executive Committee of the Multilateral Fund has already approved in principle the grant fund of US\$ 23 million to Thailand through the World Bank to implement activities proposed under HPMP Stage I during 2012-2018. In AC sector, HPMP Stage I will provide financial and technical assistance to 12 AC manufacturers with major Thai-ownership to convert to HFC-32, a mildly flammable refrigerant according to ASHRAE classification (2L).

Given that 12 AC manufacturing enterprises have been already identified and already confirmed their participation in the HPMP Stage I. The Executive Committee of the Multilateral Fund has already approved grant funds to these 12 AC enterprises to convert to HFC-32 technology. An EMP must be prepared for individual AC enterprise and be submitted as part of the sub-project proposal. Therefore, this stakeholder consultation would be a good forum to disseminate outcomes of EMP preparation as well as to receive valuable feedbacks from the stakeholders to improve and finalize the EMP for each AC enterprise.

4. Presentation on Environmental Management Plan for the AC Sector

The consultants presented scope and content of EMP. He provided an overview of related law and regulations for which the AC enterprise needs to comply for the conversion to HFC-32 technology. HFC-32 is classified as hazardous substances type 3 under the Hazardous Substances Act B.E. 2535. Provisions for which all AC enterprise must follow and comply are as follows:

- Factory Act B.E. 2535 and Ministerial Notification “Factory Fire Prevention and Control B.E. 2552” for safety standards, fire emergency and preparedness, plant equipment and machineries, discharge, emission, and waste management;
- Building Act B.E. 2522 for building utilization and fire safety;
- Occupational Safety, Health and Environment Act B.E. 2554 and Ministerial Regulation “Establishment Standard of Safety, Health and Working Environmental Management System for Fire Prevention and Control B.E. 2555 for workplace, safety, health and environment, plant equipment and machineries, fire emergency and preparedness;
- Ministerial Regulation “Occupation Safety, Health and Environmental Standards for Electrical System B.E. 2554” for electrical system inspection and maintenance;
- “DIW Notification on Storage of Chemical and Hazardous Substances B.E. 2550 for storage facility design and construction for refrigerant;
- “Notification of the Ministry of Industry, Subject: Hazardous Substances Land Transportation B.E. 2546.” for requirement for transportation of HFC-32 and requirement to appoint a competent personnel to be responsible for ensuring safety of storage, handling and use of hazardous substances.

From due diligent survey, the consultant also presented the overall assessment of the 12 AC factories. Overall, all AC enterprises have been certified to ISO 18000 and 14000. The consultant educated the participants on the relevant international standard and summarized the findings from site visit to AC enterprises. The consultant proposed additional mitigations and good practices for project proponent consideration. For instance,

- Fork lift, crane, electricity plug should be maintained in good condition at all time and no key left at fork lift and no uncertified officer can drive fork lift. Only certified officers will be allowed to drive fork lift;
- Hot work area need attention, the working space and walkway need to be cleared and tidy. No worker can walk on the conveyor, no reused soft drink bottle to fill chemical substance. Some workers still not equipped with personnel protective device while working;
- The consultant emphasized that small issues can make a fire hazard. It may not be caused by HFC-32 itself. Therefore good management practices within existing plant operation need to be improved before the conversion to HFC-32.

The consultant presented the proposed mitigation measures of which most are already in place. HFC-32 is A2L class and the velocity is lower than 10 cm. per second. The Lower Flammability Limit (LFL) and Upper Flammability Limit (UFL) of HFC-32 is 14 and 31% respectively. Although HFC-32 has quite high LFL, additional measures should be employed when converting to HFC-32. The major areas to be associated with HFC-32 are (i) charging line, (ii) storage area of HFC-32 and (iii) the storage area of finished products.

- For the storage area of HFC-32, there is need for installation of gas detector to alert the enterprise as well as exhaust fan to dilute HFC-32 concentration from the ground (as HFC-32 is heavier than air, the exhaust fan should installed at the low ground level);
- The charging line needs to have at least exhaust fan, but the gas detector may be needed depending on the condition of the enterprise;
- Refrigerant cylinder should not be put in the same place with oxygen tank. Liquefied oxygen cylinder and LPG cylinder should be 6 meter away from HFC-32 cylinder or must have fire wall. Crane and sling need to be check regularly;
- HFC-32 is a liquefied gas and less flammable when compare with LPG. However, safety transport HFC-32 cylinder is essential. HFC-32 cylinder should be put on the pallet and use fork lift to lift the pallet not directly life HFC-32 cylinder;
- HFC-32 is heavier than air and will sink down. Leaked HFC-32 can penetrate to drainage system and reach smoker outside the working area. This will cause back fire to the leaked storage tank or assembly line;

- Enterprise should be aware of back fire and flash back when dealing with oxygen tank. A diaphragm compression and flask back arrester is important. No flashback arrester will cause back fire or flash back and lead to high hazard;
- The enterprise shall ensure that no free standing compressed gas cylinder will be allowed and avoid boiling liquid expanding vapor explosion (BLEVE).
- Zoning classification of the working area was explained to the stakeholders.
- The consultant emphasized the project proponents to ensure the continuity of the implementation of those mitigation measures.

5. Comments Received

The enterprises expressed that they have experience in using LPG and thus have no objection with the proposed mitigation measures for HFC-32. With these mitigation measures, the enterprises can design the plant layout to suit the use of HFC-32. Participants expressed the following recommendations/suggestions to improve the EMP:

- One enterprise raised a concern on high cost of installation of gas detector when compared to the approved funding by the Executive Committee. The approved funding may not be sufficient for the enterprise to install the device. The World Bank should consider the approval of reallocation of approved funding from other component i.e. incremental operating cost to cover the deficit of the budget;
- The poor practice during transportation of finished products to the end user's site should be improved. HCFC-22 is not flammable gas and the poor practice does not affect the safety of the transportation (but may affect the condition of the product). Awareness should be educated to the workers of the retailers and wholesalers. Moreover, the use of warning label at the box of the products would help to increase awareness of the workers;
- For storage of finished product, the need for gas detector depends on the practice of the enterprises (i.e. the enterprise has checked leak test during the assembly process or not. The enterprise may consider installing sprinkle at the storage warehouse of finished product but not gas detector);
- Suppliers of oxygen tank, refrigerant cylinder, LPG cylinder should play an important role and responsibility to support the AC enterprises in dealing with flammable substances.
- Daikin is the pioneer of this technology and has had experience in designing the plant layout and manufacturing HFC-32 based AC. The project proponent proposed to have a site visit to Daikin to allow the enterprises to understand the plant layout and safety measures put in place for the use of HFC-32. This would be benefits for the enterprises to have better idea and understand how to convert their production process to this technology;
- AC enterprises urged Daikin to play leadership role to launch HFC-32 based product in Thailand as soon as possible.

Workshop's Photo

